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POLLUTION OF LAKE ERIE AND ITS TRIBUTARIES - INDIANA, MICHIGAN, NEW YORK, OHIO, PENNSYLVANIA. PROCEEDINGS OF PROGRESS EVALUATION MEETING HELD AT CLEVELAND, OHIO ON JUNE 4, 1968

Federal Water Pollution Control Administration
Washington, D. C.

4 June 1968

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PROCEEDINGS

DETROIT
BUFFALO
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CLEVELAND
FORT WAYNE

June 4, 1968
Cleveland, Ohio

PROGRESS EVALUATION MEETING

Pollution of Lake Erie and its Tributaries-- Indiana, Michigan, New York, Ohio, Pennsylvania

NATIONAL TECHNICAL INFORMATION SERVICE

U.S. DEPARTMENT OF THE INTERIOR • FEDERAL WATER POLLUTION CONTROL ADMINISTRATION 824

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Progress Meeting of the Conference in the matter of pollution of the waters of Lake Erie and its tributaries (Indiana-Michigan-New York-Ohio-Pennsylvania), held at the Pick Carter Hotel, Cleveland, Ohio, on June 4, 1968, at 9:30 a.m.

- - -

PRESIDING:

Mr. Murray Stein, Assistant Commissioner for Enforcement, Federal Water Pollution Control Administration, Department of the Interior.

- - -

CONFEREES:

Dwight Metzler, Deputy Commissioner, New York State Department of Health, Division of Pure Waters, Albany, New York

George H. Eagle, Chief Engineer, Ohio Department of Health, Columbus, Ohio

Loring F. Oeming, Executive Secretary, Michigan Water Resources Commission, Lansing, Michigan

Blucher A. Poole, Technical Secretary, Indiana Stream Pollution Control Board, Indianapolis, Indiana

CONFEREES, Continued:

Walter A. Lyon, Director, Division of Sanitary Engineering, Pennsylvania Department of Health, Harrisburg Pennsylvania

H. W. Poston, Regional Director, Great Lakes Region, Federal Water Pollution Control Administration, Department of the Interior, Chicago, Illinois

PARTICIPANTS:

Hon. Thomas Ashley, U. S. House of Representatives Washington, D.C.

Hon. Charles A. Vanik, U. S. House of Representatives, Washington, D.C.

Arnold Reitze, Associate Professor of Law, Case Western Reserve University, Citizens for Clean Air and Water, Cleveland, Ohio.

Gerald Remus, General Manager, Detroit Water Board, Detroit, Michigan.

Hon. Carl Stokes, Mayor, city of Cleveland, Ohio.

Hon. Richard D. McCarthy, U. S. House of Representatives, Washington, D.C.

George Simpson, Consulting Engineer, Havens and Emerson, Cleveland, Ohio.

PARTICIPANTS, Continued:

Hon. Jacob K. Javits, United States Senate, Washington, D.C.

William Riley, Sanitary Engineer, Great Lakes Regional Office, Federal Water Pollution Control Administration, Chicago, Illinois.

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Perry Miller, Assistant Director, Division of Sanitary Engineering, Indiana State Board of Health, Indianapolis, Indiana.

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John Chascsa, President, Lake Erie Clean-Up Committee, 3568 Brewster Road, Dearborn, Michigan.

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John E. Kinny, Consulting Engineer, Ann Arbor, Michigan.

Mrs. James Angel, Chairman, Citizens for Land and Water Use, Lakewood, Ohio.

Seba Estill, Izaak Walton League, 3577 Cummings Road, Cleveland, Ohio.

- - -

ATTENDEES:

Donald Alexander, East Cleveland, Ohio.

Mrs. James H. Angel, Chairman, Citizens for Land and Water Use, 2084 Elbur Avenue, Lakewood, Ohio.

Mary C. Ansbro, Editor, Water in the News.

J. H. Bailey, Executive Manager, Tourist and Convention Bureau of Erie County, 1611 Peach Street, Erie, Pennsylvania.

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ATTENDEES, Continued:

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Miss Erie of 1968, Erie, Pennsylvania.

Seba H. Estill, Izaak Walton League, 3577 Cummings Road, Cleveland, Ohio.

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ATTENDEES, Continued:

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ATTENDEES, Continued:

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John Hyland, Regional Enforcement Officer, Federal Water Pollution Control Administration, Wheeling, West Virginia.

R. L. Ireland, Lake Erie Watershed Foundation, Cleveland, Ohio.

ATTENDEES, Continued:

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ATTENDEES, Continued:

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Arthur Marohn, Forest City Civic Association.

Charles Marquetta, South East Club.

Helen McCue, Executive Committee, Mother's March on Pollution.

Stephen Megregian, 2522 Pierce, Ames, Iowa.

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Dan McIver, Dow Chemical Company, Midland, Michigan.

Mrs. Hermine Merkle, Water Resources Chairman, League of Women Voters, Citizens for Land and Water Use, Citizens for Clean Water and Air.

ATTENDEES, Continued:

Frank S. Merritt, Burton, Ohio.

Perry Miller, Assistant Director, Division of Sanitary Engineering, Indiana State Board of Health, Indianapolis, Indiana.

Peter T. Miller, Cinematographer, WJW-TV, Cleveland, Ohio.

R. J. Manson, District Engineer, Ohio Department of Health, Bowling Green, Ohio.

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Mrs. H. T. Moore, Chairman, League of Women Voters, Lake Erie Basin Committee, Chardon, Ohio.

H. M. Mueller, Regional Manager, Neptune Micro Floc, Elk Grove Village, Illinois.

Jeffrey Myers, Cleveland, Ohio.

Donald L. Norling, Deputy Director, Ohio Department of Natural Resources, Columbus, Ohio.

Charles W. Northington, United States Public Health Service, Dallas, Texas.

Edwin J. Odeul, Sanitary Engineer, Ohio Department of Health, Cuyahoga Falls, Ohio.

ATTENDEES, Continued:

James P. O'Keeffe, Director of Conservation and Resources, United Auto Workers, Columbus, Ohio.

Nicholas V. Olds, Assistant Attorney General, State of Michigan, Lansing, Michigan.

Laurence D. O'Leary, Director, Detroit Program Office, Federal Water Pollution Control Administration, Grosse Ile, Michigan.

Dr. Paul Olynyk, Assistant Professor, Cleveland State University, Cleveland, Ohio.

R. H. Papenfuss, Plant Manager, Olin Mathieson, Ashtabula, Ohio.

John Pegors, President, Clear Air, Clear Water, Unlimited, No. Hopkins, Minnesota.

Charles Ownbey, Federal Water Pollution Control Administration, Great Lakes Region, Chicago, Illinois.

David E. Perriman, Assistant Director, Division of Oil and Gas, New York State Conservation Department, Albany, New York.

R. J. Pickering, Associate District Chief, United States Geological Survey, Water Resources Division.

Peter J. Piecuch, Assistant Editor, Environmental Science and Technology, Washington, D.C.

Rheta Piere, Federal Water Pollution Control Administration, Washington, D.C.

ATTENDEES, Continued:

Mrs. Carol Pietrykowski, Councilman, City of Toledo, Toledo, Ohio.

P. R. Pine, Vice President, Harshaw Chemical Company, Cleveland, Ohio.

Blucher A. Poole, Director, Bureau of Environmental Sanitation, Indiana State Board of Health, Indianapolis, Indiana.

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Arnold Reitze, Associate Professor of Law, Case Western Reserve University, Citizens for Clean Air and Water, Cleveland, Ohio.

Gerald Remus, General Manager, Detroit Water Board, Detroit, Michigan.

ATTENDEES, Continued:

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Walter Rodenberger, Waste Control, Republic Steel Corporation, Cleveland, Ohio.

Lawrence W. Rollin, Process System Engineer, NASA, Lewis Research Center, Cleveland, Ohio.

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Aaron A. Rosen, Cincinnati, Ohio.

Ray Roth, Superintendent, Bureau of Industrial Waste, city of Cleveland, Cleveland, Ohio.

James L. Rouman, Executive Director, Michigan United Conservation Clubs, Lansing, Michigan.

Robert W. Ruch, NASA, Plum Brook Station, Sandusky, Ohio.

Agnes V. Rupp, Parma, Ohio.

Anthony Russo, State Representative of Ohio, Cleveland, Ohio.

D. W. Ryckman, President, Ryckman, Edgerley, Tomlinson and Associates, St. Louis, Missouri.

Krish Saigal, Sanitary Engineer, Dalton and Dalton, Cleveland, Ohio.

James P. Schafer, Bacteriologist, City of Cleveland.

ATTENDEES, Continued:

Robert L. Schueler, River Basins Studies Coordinator, Bureau of Commercial Fisheries, Ann Arbor, Michigan.

Eugene Seebald, Regional Engineer, New York State Department of Health, Buffalo, New York.

David Scullin, Aqua Laboratories, Cleveland, Ohio.

Bryan J. Sevey, Engineering Supervisor, Monsanto Company, Trenton, Michigan.

A. M. Shannon, Chief, Water and Waste Water Treatment, Detroit Metropolitan Water Services, Detroit, Michigan.

George Simpson, Consulting Engineer, Havens and Emerson, Cleveland, Ohio.

Ned Skeldon, Administrator, Clear Water, Inc., Toledo, Ohio.

Al Smith, Federal Water Pollution Control Administration, Cleveland Program Office, Cleveland, Ohio.

John J. Smith, Detrex Chemical Inc., Cleveland, Ohio.

Mrs. Richard Smith, League of Women Voters of Ohio, Cleveland, Ohio.

Peter E. Snoek, Senior Engineer, Bechtel Corporation, San Francisco, California.

ATTENDEES, Continued:

A. D. Staursky, Assistant Director Public Relations, United States Steel, Cleveland, Ohio.

Evelyn Stebbins, League of Women Voters, Chairman, Three Rivers Group, Rocky River, Ohio.

Ben S. Stefanski, Utilities Director, city of Cleveland, Cleveland, Ohio.

Edward F. Stevenson, Engineer, NASA, Lewis Research Center, Cleveland, Ohio.

Carl Stokes, Mayor, city of Cleveland, Cleveland, Ohio.

Mark E. Talisman, Administrative Assistant to Congressman Charles Vanik, Washington, D.C.

John Toth, Sanitary Engineer, Water Pollution Control, Erie County Department of Health, Erie, Pennsylvania.

J. W. Tracht, Manager, Maintenance of Facilities, Pennsalt Chemical Corporation, King of Prussia, Pennsylvania.

F. E. Tucker, National Steel Corporation, Pittsburgh, Pennsylvania.

W. G. Turney, Regional Engineer, Michigan Water Resources Commission, Lansing, Michigan.

Harry L. Vanderwoop, Technical Director, Peerless Cement, Detroit, Michigan.

ATTENDEES, Continued:

John F. Slambroack, Mayor, city of Monroe, Michigan.

George Voinovich, State Representative, Fifty-third District, Cleveland, Ohio.

Harry Von Huben, Sanitary Engineer, Headquarters Fifth United States Army, Fort Sheridan, Illinois.

Henry J. Vyhnalek, Supervisor Plant Chemist, Cleveland Electric Illuminating Company, Cleveland, Ohio

Adel Wagner, Lakewood, Ohio.

Fred Wampler, Regional Coordinator, Ohio Basin Region, Federal Water Pollution Control Administration, Cincinnati, Ohio.

Dale Warner, Parma Heights, Ohio.

Mrs. Neil Waterbury, Northwest Ohio Natural Resource Council, Toledo, Ohio.

George H. Watkins, Executive Director, Lake Erie Watershed Conservation Foundation, Cleveland, Ohio.

Erbin Wattles, President, Dunbar and Sullivan Dredging Company.

P. J. Weaver, Chairman, Technical Committees, Soap and Detergent Association, New York City.

Neil M. Waterbury, President, Northwestern Ohio Natural Resources Council, Toledo, Ohio.

ATTENDEES, Continued:

Gregory A. Weiss, Legal Department, Cleveland Electric Illuminating Company, Cleveland, Ohio.

Edward Wellejus, Reporter, Erie Times, Erie, Pennsylvania.

Thomas C. West, Director of Environmental Health, Erie County Department of Health, Erie, Pennsylvania.

G. L. Whitney, Engineer, Dorr-Oliver, Inc., Columbus, Ohio.

Alfons R. Winklhofer, Chief, Field Operations Unit, Cleveland Program Office, Federal Water Pollution Control Administration, Cleveland, Ohio.

Betsey Winters, Cleveland, Ohio.

John J. Wirts, Chemical Engineer, Easterly Pollution Control Center, Cleveland, Ohio.

Colonel A. L. Wright, District Engineer, Buffalo Corps of Engineers, Buffalo, New York.

Donald J. York, Director of Public Utilities, city of Toledo, Ohio.

PROCEEDINGS

- - -

CHAIRMAN STEIN: The Conference is open. This conference in the matter of water pollution of Lake Erie is being held under the provisions of the Federal Water Pollution Control Act. We have had several conferences on the lake.

We are holding this session as a progress meeting. The conference involves the five Lake Erie States and the Federal Government, as represented by the United States Department of the Interior.

We will make a summary of the meeting. We will also have a transcript made, and the transcript, of course, as many of you know, will be available in about three or four months. However, if you want copies of the transcript or portions thereof earlier, contact the reporter, Mrs. Hall and Mrs. Hall will be glad to make arrangements with you so you can get it. You should understand that Mrs. Hall is an independent contractor and you will make your arrangements with her privately if you want this information.

The speakers, other than the conferees, should identify themselves by name and affiliation and see that the reporter receives a copy of their remarks, if they have any, and come to the lectern to make their remarks.

We will have comments and questions by the conferees. We are asking all of you to withhold your questions or remarks until you come up for your statement.

At this point, I would like to start at the left and ask the conferees to identify themselves. Mr. Eagle, would you begin, and I would ask you all, until the PR system gets operating, if it does, to please raise your voice and try to project.

MR. EAGLE: My name is George H. Eagle. I am Chief Engineer of the Ohio Department of Health and I am representing the State of Ohio.

MR. METZLER: Dwight Metzler, Deputy Commissioner, New York State Health Department.

MR. OEMING: Loring Oeming, Executive Secretary, Michigan Water Resources Commission, Lansing.

MR. POSTON: H. W. Poston, Great Lakes Regional Director for the Federal Water Pollution Control Administration, Chicago, and I am the Federal Conferee.

MR. POOLE: I am Blucher Poole, Technical Secretary of the Indiana Stream Pollution Control Board and representing the State of Indiana.

MR. LYON: I am Walter Lyon, Director of the Division of Sanitary Engineering in the Department of Health in Pennsylvania, representing Pennsylvania.

CHAIRMAN STEIN: My name is Murray Stein. I am from Washington, D.C., and the representative of Secretary Stewart Udall.

We are going to try to adjust the agenda as best we can. First, we have a representative here who is ready to make a presentation, but he has a very tight schedule and commitments back in Washington this morning, and first we would like to call on Congressman Thomas L. Ashley of the Ninth District of Ohio. Congressman Ashley.

MR. ASHLEY: Thank you, Mr. Chairman.

Panel of officials, ladies and gentlemen. Any discussion of the desperate state of pollution of Lake Erie must take into full account that for many years both the United States and Canada have been and continue to be in flagrant violation of the law which exists pursuant to a treaty entered into by the two countries in 1909 providing for the adjustment and settlement of all questions which might arise between the United States and Canada with respect to the use of boundary waters. The treaty, which is still in full force and effect, defines boundary waters as "the waters from mainshore to mainshore of the lakes and rivers and connecting waterways, or the portions thereof, along which the international boundary between the United States and the Dominion of Canada passes ..." Obviously this includes Lake Erie.

Article IV of the treaty specifically provides that "boundary waters and waters going across the boundary shall not be polluted on either side to the injury of health or property on the other."

Article VIII establishes an order of preference with respect to various uses for these waters, with water for domestic and sanitary purposes having highest priority, followed next by water used for navigation, then for power and irrigation.

Contrary to Article IV, providing that boundary waters shall not be polluted on either side, we find that six per cent of municipal waste, from a population of ten million Americans living along the shores of Lake Erie in 1965, were deposited in the lake with no treatment at all, that forty-one per cent received only primary treatment and fifty-three per cent received secondary treatment.

About seventy-nine per cent of the municipal waste from the Canadian population of 1.2 million living on Lake Erie in 1965 received secondary treatment, twelve per cent primary treatment and nine per cent no treatment.

Similarly, according to the 1965 Interim Report of the International Joint Commission, the United States in 1965 had 271 and Canada 63 sources of industrial waste along Lake Erie, many of which were classified as being subject to inadequate treatment. The report also noted that waters from overland runoff and deep percolation contained agricultural and other wastes which affect the quality of the receiving waters, and of course this is especially true of Lake Erie.

A surprising omission in the Commission Report was the extent to which the Federal Government of the United States is itself in constant violation of the 1909 Treaty and therefore of Federal law. It is also surprising that the agenda of this conference, as set forth in the Department of Interior release of May 15, 1968, fails to list for discussion the activities of the United States Government which continue to pollute the waters of Lake Erie in violation of our law.

The agenda is silent on the fact that last year -- 1967 -- United States Government dredging projects at fourteen Lake Erie harbors produced a total of 7,671,000 cubic yards of polluted dredged material. Of this total, 5,438,000 cubic yards were dumped at so-called "authorized" disposal areas in Lake Erie.

For 1968, also according to data received from the Office of the Chief of Engineers, Government dredging at these same harbors is expected to produce 7,015,000 cubic yards of spoil material, virtually all of it polluted. Of this total, 5,302,000 cubic yards are planned for open lake disposal.

Since the 1965 Interim Report of the International

Joint Commission, United States efforts to bring Government dredging operations within the law have been anything but noteworthy or encouraging. In 1967, 2.2 million cubic yards of Government dredged spoil material were consigned to diked area disposal. For 1968, the amount of polluted material resulting from Government dredging that will be consigned to diked areas is expected to be only 1.7 million cubic yards.

What this means quite clearly is that about 71 per cent of the polluted material resulting from Federal dredging activities in 1967 was dumped into Lake Erie in violation of the law as againt 29 per cent that was properly diked, and that in 1968 unlawful open lake dumping is expected to increase to more than 75 per cent, as against only 25 per cent that will be diked.

When I state that this activity is in violation of the law, let me again refer to Article VIII of the Treaty. If I interpret this language correctly, it means that the use of lake waters for domestic and sanitary purposes is given preference over other uses and no use shall be permitted, including dredging for navigation that results in the pollution of lake waters, which tends materially to conflict with the highest priority of water uses, namely for domestic and sanitary purposes.

Yet, completely contrary to this policy and prohibition, the Department of the Army takes the position, as stated in a letter to me, dated May 3, 1968, that "because of severe economic hardship ... and because no disposal areas other than the authorized deep water areas of Lake Erie are now available, it has been determined that dredging in 1968 must be done and the dredged material disposed in the lake." Although fully aware that the spoil material thus consigned for lake disposal is bound to result in further pollution, the letter concludes with the assurance that "the Corps of Engineers will continue its efforts, in coordination with FWPCA and state authorities, to construct and maintain harbors in consonance with the national objective of cleaning up our rivers and lakes at the lowest possible cost."

With respect to Lake Erie, the Corps apparently has determined that the cheapest way to clean it up is to fill it up. The fact is that the Corps is not maintaining harbors on Lake Erie with the national objective of cleaning up our rivers and lakes. What it is doing is dredging at the lowest possible cost by "authorizing" so-called "deep water" disposal areas along the entire United States shoreline of Lake Erie -- areas which it has no right to authorize and which, in point of fact, are both shallow and in many cases in immediate proximity to municipal water intakes serving hundreds of thousands of people.

The result of this Federal activity is to constantly add to rather than abate the pollution of Lake Erie waters. Federal justification for pursuing this policy is said to be drastic hardship to navigation, a use which somehow has leapfrogged in priority over the "uses for domestic and sanitary purposes" that are given preference in the Treaty of 1909.

Now, let me comment on the problem of disposal of materials dredged from harbors and waterways under permits issued by the Corps of Engineers.

In 1967, such permit dredging accounted for 185,000 cubic yards of dredged material, all of which was polluted and all of which was dumped in open lake disposal areas. In 1968, contract dredging pursuant to permits issued by the Corps of Engineers has already more than doubled and 348,000 cubic yards of additional polluted material have been added to Lake Erie waters so far this year. These figures, of course, do not include a large number of applications presently pending for approval or expected to be filed for permit dredging this summer and fall.

One permit for private dredging not yet acted upon by the Corps has generated particular interest. It involves the application of the Dunbar and Sullivan Dredging

Company of Detroit to dredge 295,000 cubic yards of especially badly polluted spoil and scum from the bottom of the Rouge River and to dump it in shallow waters in Western Lake Erie within less than 2000 yards of the international boundary.

The policy of the Corps of Engineers appears to be ambivalent. The Corps itself dredges polluted spoil from the Rouge River which, because of its condition, it deposits on Grassey Island rather than in the lake. At the same time, its District Office recommended approval last year of a permit to allow private dredging of the same contaminated material for disposal in the shallow waters of Lake Erie.

Again in 1967 the same private dredging company was in the process of dumping into Lake Michigan, with the Corps of Engineers' approval, some 203,000 cubic yards of highly polluted dredging similar in character to the spoil material in the Rouge River. In the wake of public outcry and vigorous representations from the Illinois Congressional delegation and the Governor of Illinois, this dumping was found to be contrary to the public interest and was halted.

In a letter to me, dated May 31, 1968, Assistant Secretary of the Interior Max N. Edwards advised me, relative to the proposed permit dredging of the Rouge River for open lake disposal, that "in view of the nature of the sediments to be dredged, the Federal Water Pollution Control Administration Regional Office has recommended to the United States Corps of Engineers that the dredgings concerned not be disposed of in Lake Erie, but be placed in upland areas so that pollution of Lake Erie will be prevented. Recognizing the shortage of suitable on-shore disposal sites for such materials, (your) suggestion that this material be placed on the Grassey Island disposal site appears to be appropriate from a pollution control viewpoint. We understand, however, that this approach has been rejected by the Corps."

All of this suggests to me, in the strongest possible terms, that the final decision with respect to issuance of dredging permits, where the material to be disposed of has been found to be polluted, should rest with the Secretary of the Interior rather than the Secretary of the Army. Under a July 13, 1967, agreement between the Secretaries of these two Departments, the Secretary of the Army is given the authority to evaluate the economic advantages and benefits of a proposed dredging operation in relation to resultant loss or damage, including violation of applicable water quality standards, and to either deny the permit or include such conditions as he determines to be in the public interest.

In my view, if Lake Erie is to be saved, strong pollution abatement enforcement should not be subject to a waiver based upon temporary economic convenience or advantage. Activity which contaminates the water upon which our very lives are dependent must be outlawed and uniform enforcement should be in the hands of the agency having primary responsibility for establishing water quality standards and seeing that they are met.

Let me say in conclusion that there must be a prompt clarification of Federal policy if the confidence, support and commitment of our citizenry is to be sustained in fighting pollution and achieving a national goal of clean water.

Thank you, Mr. Chairman.

CHAIRMAN STEIN: Thank you, Congressman Ashley.

I would like to tell you that we will have an opportunity for full discussion of the dredging problem and the Federal installation problem at this meeting. It is on the agenda. The Corps will make a statement, I think, but this will be open. That has not been excluded from the agenda.

One more factual point: Under the law, the Corps does have the authority to determine where they are going to dredge and the disposal of the dredged material; the law provides that. We do not have that authority in the

Department of the Interior.

MR. ASHLEY: The question is whether the law authorizing the Army to -- so-called "authorizing" -- use these open-length disposal areas is a proper law. I think it is an absolute violation of the Treaty of 1909.

CHAIRMAN STEIN: Thank you.

MR. METZLER: Mr. Chairman, may I ask the Congressman a question?

CHAIRMAN STEIN: Surely.

MR. ASHLEY: Yes, sir.

MR. METZLER: I am Dwight Metzler from New York.

I am sympathetic to the point of view that you present here. I want to inquire, though, do you feel that Congress is sufficiently informed on this that they are ready to authorize costs of perhaps three or four times as much for disposal of dredged materials as now is appropriated to the Corps today?

MR. ASHLEY: I think we may be faced with those increased costs. When the choice is between the salvation of our lakes and the increased cost, we will go in the direction of the increased cost, yes, sir.

We have been approaching the whole dredging situation with a myopic view. We have been concentrating entirely on cost, and the Congress has insisted on this and the result has been the pollution of five of the greatest bodies of water on the face of the earth.

CHAIRMAN STEIN: One more point, Congressman Ashley, I think on that Lake Michigan dredging situation that the record will also show that the conferees, many of whom are represented here, participated in the dredging discussions of Lake Michigan and the disposal of the spoil. This happened after the Illinois delegation came in, and I think the discussions at our conference with the representatives of the States bordering Lake Michigan, the Corps of Engineers and the Department of the Interior were very useful in working up at least a program of action to terminate disposal in Lake Michigan.

MR. ASHLEY: But that disposal had been approved and the permit granted by the Corps of Engineers, isn't that correct? They were dumping in 100-foot water as distinct from the shallow depths.

CHAIRMAN STEIN: No, there is much land disposal there. Again -- and I don't know that this is the time to get into the detail, but the problem that we always have of land disposal -- and the Corps can speak for itself -- is a very complex one. You have to find appropriate sites and a site large enough to be able to take the spoil for a considerable period of time, in order to make that an efficient operation, because you can't shift your disposal operations from place to place. We did get some of the industries along the southern end of Lake Michigan to cooperate, to give us land, make land available and enclosed areas behind dikes available for the disposal of the dredged material. I think we have a reasonable program worked out there. I am hopeful that we can get one here.

MR. ASHLEY: You brought this up, and I know you don't want to go into details now. But all I said is that the Corps of Engineers had issued a permit, that polluted dredging was being dumped into Lake Michigan, that hearings were held, protests were heard, and this activity polluting Lake Michigan was found to be contrary to the public interest, despite the fact that the Corps of Engineers, on the basis of all the information earlier presented to it, had granted the permit for the dumping in the first place.

CHAIRMAN STEIN: Well, it was precisely a meeting such as this on Lake Michigan at which we arrived at that program and those conclusions; that is why we are here.

MR. ASHLEY: That is why I am recommending that the authority of the Corps of Engineers be taken and placed in the Department of Interior. (Applause)

CHAIRMAN STEIN: At this point, we have also had a previous request. We will now hear from Professor Reitze from the Citizens for Clean Air and Water, Inc.

Professor Reitze.

While you are coming up, I have another communication here and a statement from Congressman Charles A. Vanik, who would like this included in the record, and his schedule, he writes, precludes him from personally presenting this statement. As you know, Congressman Vanik is from Ohio. Without objection, I would like to give the statement to the reporter and have it entered into the record as if read. (Prepared statement follows.)

MR. VANIK: Mr. Chairman. Almost three years ago, on August 3, 1965, I attended the first Lake Erie Water Pollution Conference at Cleveland. At that time, our hopes were high that speedy action would be taken to stop the deterioration of Lake Erie. At that time, we were told of dramatic actions which would be taken to clean up the lake. We were told that cleanup orders would be issued, that injunctions would be sought against the contaminators, that the Federal Government would move with dispatch where it had jurisdiction.

At this fourth conference, we are still in a talkathon on the pollution problem. Water quality is getting worse by the hour -- and the hour is late.

Since the first conference, it is important to note that the Federal Government has granted over $20,000,000 to help meet the water pollution problem in

Ohio. As can be noted from the list of grants and the benefited communities, the Lake Erie pollution problem has been completely overlooked. Federal water pollution funds have filtered, in the main, to small towns and hamlets. It is a rural program.

Since the first conference, the State of Ohio has not appropriated a single dollar toward meeting the problem. It has used the contribution of local governments to make up the matching grant.

It seems to me that it is important for the conference to identify and comment on the lack of state participation so that the community can recognize this flagrant failure of State participation and do something about it.

At the first conference in 1965, I directed the first attention in the Nation to the contribution to the water pollution problem resulting from the dumping of polluted dredged material into Lake Erie by the United States Army Corps of Engineers. After much deliberation, the Army Corps of Engineers announced they would meet this problem by dumping dredged material, at least in part, in diked areas. In 1967, of 7,671,000 cubic yards of dredged material, 5,438,000 cubic yards were dumped into Lake Erie while 2,233,000 cubic yards were consigned to diked area disposal, mostly at Toledo Harbor.

For fiscal 1968, Government dredging in Lake Erie is expected to produce 7,015,000 cubic yards of material. Of this, 5,302,000 cubic yards will be dumped in Lake Erie, while 1,713,000 cubic yards will be consigned to diked areas.

The above figures reveal that of total government dredging in 1967, amounting to 7,671,000 cubic yards of polluted material, 70.9 per cent was dumped in Lake Erie. Of the 7,015,000 cubic yards of Government dredging predicted for 1968, by contrast, 75.5 per cent will be consigned to open lake disposal areas.

I am shocked that in 1968 the Federal Government will dike approximately 500,000 cubic yards less of Lake Erie dredgings than was diked in 1967, or a total of 1.7 million cubic yards in 1968 as compared with 2.2 million cubic yards in 1967. It appears that the Government, under the pressures of anti-pollution forces in 1967, responded with a "token effort" in meeting the pollution problem with a gradual phase out of this effort in 1968 and future years.

The indignation of the people of my community will not tolerate a "token effort" to solve the water pollution problem of Lake Erie by either the Federal Government or the State of Ohio. The public protest will not tire or terminate. Concrete proposals must be vigorously pursued to reduce the Federal Government contribution to the pollution problem. Until this is accomplished, the entire dredging program of the Corps of Engineers will be placed in jeopardy.

CHAIRMAN STEIN: Professor Reitze.

MR. REITZE: Mr. Chairman, conferees. My name is Professor Reitze, Associate Professor of Law, at Case Western Reserve University. I represent today Citizens for Clean Air and Water.

It is my pleasure to appear here today before the Federal Water Pollution Control Administration as a representative of Citizens for Clean Air and Water, Inc. This is an organization of citizens from Greater Cleveland who are interested in a dynamic program of water and air pollution abatement.

Our program has been endorsed by: the Area Council, the Cleveland Audobon Society, the Edgewater Yacht Club, the Greater Cleveland Boating Association, the Holy Family P.T.U., the Izaak Walton League, and the Rocky River Kiwanis.

I shall discuss three subjects:

1. The Ohio water quality standards;

2. The proposed application of those standards to the Rocky, Cuyahoga, Chagrin and Grand River Basins and the consequent effect on Lake Erie;

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3. The progress to date of pollution abatement activities.

As you know, the intent of the Federal Water Pollution Control Act (P.L. 84-660), as amended, is to maintain high quality water where it now exists and to upgrade and enhance water quality where degradation is presently found. When Secretary of the Interior Stewart Udall testified before the Senate Subcommittee on Air and Water Pollution, March 27, 1968, he outlined the eight basic principles used by his Department when reviewing state water quality standards. They are:

1. No degradation of existing water quality;

2. No waters shall be used solely or principally as a waste carrier;

3. All wastes must receive the best practicable treatment or control prior to discharge into any interstate water;

4. A general acceptable range of values for key indicators of water quality has to be developed, especially with respect to dissolved oxygen and temperature;

5. There must be consistency among standards of adjacent and downstream states;

6. Water quality standards must be adequate to protect and upgrade water quality in the face of population and industrial growth, urbanization, and technological

change;

7. There shall be no exemptions from the standards for a particular industry or area; and,

8. Standards must be feasible and achievable.

It is extremely difficult to comprehend how Ohio's standards can meet these Federal tests. Ohio has created seven water quality standards. The two criteria of lowest quality are Industrial Water Supply and the euphemistic Aquatic Life B. These criteria allow dissolved oxygen of 2.0 mg/liter, a pH between 5 and 9, and a temperature not to exceed 95 degrees Fahrenheit. It is difficult to imagine water of this quality not violating the Federal prohibition against using water primarily as a waste carrier. It is also difficult to believe this water is receiving the best practicable treatment prior to discharge.

Not only are Ohio's water standards low, but the criteria making up the standards vary so much from category to category that it is difficult to use them for meaningful results. Thus, in the Public Water Supply category, there is no limitation on pH, temperature or toxic substances. Neither Aquatic Life A or B has a bacteria criteria. The Recreation criteria calls for a bacteria limitation only. Presumably water skiing in hot acid is a proper recreational use. The Agricultural Use and Stock Watering category is the strangest of all, for it places no limitation on pH, temperature, bacteria, or dissolved oxygen. Finally, there are no limitations on nutrients even though this is the most serious pollutant of Lake Erie.

Even poor standards, if applied to maximize water improvement, would achieve significant advances. When we look at the application of Ohio stream quality criteria to the Grand, Cuyahoga, Chagrin and Rocky Rivers we have little reason for optimism. The Ohio Water Pollution Control Board has not yet zoned the waters flowing into Lake Erie so as to apply the water quality standards to specific segments of the four rivers which are the subject of this discussion. However, if the Board follows the recommendation of the Division of Engineering of the Ohio Department of Health, we can expect continued pollution of these rivers and, therefore, continued pollution of Lake Erie.

If the Health Department recommendations are accepted, then, continued pollution will be legitimatized by law. One example is their recommendation that the Cuyahoga River from State Highway No. 17 to the U.S. Coast Guard Station should have until January 1, 1975, to meet Aquatic Life B criteria, and until January 1, 1971, to meet Industrial Water Supply criteria. Thus, no bacteria limitation will be placed on this body of water in the near future. In addition, a goal of water so inferior in quality that fish cannot live in it is accepted as a goal to be pursued through government action. Even if we meet this goal, in 1975 we will still be polluting the nearby Lake Erie beaches -- Perkins, Edgewater, White City, and Wildwood. When our leaders' vision is so myopic, we can only conclude that the great society will not include swimming.

The recommendations for the Rocky River follow the same approach used toward the Cuyahoga. Minimum standards are sought. A new category, Partial Body Contact, is proposed. This would allow a bacteria coliform group not to exceed 5,000 per 100 ml. Water of this proposed quality is unsafe for swimming or for use by children. There is no proposal for increasing this standard. In addition to low quality water as a proposed goal, these Rocky River proposals violate the Federal guidelines in that the proposed standards are in some instances -- particularly regarding temperature, pH, and oxygen content -- below the existing condition of the water.

These recommendations of the Division of Engineering could be attacked one by one for the rest of the day. This is unnecessary. These proposed quality standards assume a defeatist attitude by accepting minimal standards. The necessary pollution abatement controls are known by everyone. The real problem is that there has been insufficient commitment to pollution abatement. Studies are used as substitutes for standards and standards are watered down substitutes for programs that would in fact end pollution. You will not end pollution until you stop putting pollutants in our waters. This simple fact has a tendency to disappear in the haggling over the proper criteria for water quality standards.

In August of 1965 the first of these pollution conferences was held. The revised conclusions and recommendations of the conferees issued on August 12, 1965, set forth twenty-seven conclusions. Some of these conclusions concern the quality of Lake Erie waters. Today, three years later, they could be rewritten at the conclusion of this conference. Lake Erie is still polluted. Eutrophication or over-fertilization is still a major concern. Many sources of waste discharge reaching Lake Erie still have inadequate waste treatment facilities.

The 1965 report, however, makes specific recommendations as to how to abate pollution. It is interesting to read them today as nearly three years have passed for implementing the recommendations.

Conclusion No. 7 said municipal wastes are to be given secondary treatment, while Conclusion No. 9 called for the disinfection of municipal waste effluent so as to maintain coliform densities below 5,000 organisms per 100 ml. Today, two communities still have only primary treatment. Much more serious is that inadequate treatment plants still abound in all four watersheds which are the subject of this discussion.

Conclusion No. 8 called for treatment plants to maximize the removal of phosphates. This simply is not being done. Conclusion No. 18 required waste results to be reported in terms of both concentration and load rates with the information to be maintained in open files by the state agencies for all those having a legitimate interest. Not only has this not been carried out, but Ohio Revised Statute 6111.05 states that records of a private disposal system may not be made public without the express permission of the owner. The State of Ohio by statute protects the pollutors' nefarious activities from public scrutiny.

Conclusion No. 25 gave the U.S. Army Corps of Engineers six months to develop a program to end the disposal of dredged material in Lake Erie. They are still dumping the material in the lake.

These examples are by no means the only failures to meet the recommendations of the conferees. If the 1965 recommendations are used as the measure of progress, then, there has not been much progress. In fact, indications are that Lake Erie is more polluted today than it was three years ago.

During the past three years some industries and some municipal governments have spent a great deal of money on pollution abatement facilities. Many industries and municipal governments have firm plans which will require even greater expenditures. However, when listening to industry or government defend their actions, we should apply the same test that an industry applies to a sales executive. We should look at results. Are they or are they not ending the pollution of our waterways? We are aware of the time it takes to put pollution abatement equipment into operation; but, industry and government have already had three years. Why is it that after three years of so-called progress, a sludgeworm or a leech cannot live in the lower Cuyahoga River? The answer is that the commitment to pollution abatement is not a serious commitment. The State of Ohio has yet to give one nickel to the City of Cleveland for water pollution control.

The City of Cleveland has spent a great deal of money on sanitation treatment plants, yet, inadequately treated wastes from the Southerly Treatment Plant, storm-water overflows, and sewage bypasses discharge large quantities of oxygen-demanding wastes and bacterial contamination into the Cuyahoga River and then into Lake Erie. While this gunk goes into the Cuyahoga and Lake Erie, Cleveland can claim the dubious honor of having the lowest sewage charge of any major city in the United States. Industry, one of the major pollutors of the Cuyahoga, has spent many millions of dollars, but in terms of the value added to goods manufactured in this area, the expenditures have been minimal.

Our conclusion is that pollution abatement has been moving much too slowly. If the recommendations of the Division of Engineering of the Ohio Department of Health are accepted, we can all look forward to a vile polluted Cuyahoga River for many, many years to come. We, therefore, make the following suggestions as to how to speed up the protection of our valuable water resources:

1. An effluent tax should be placed on all pollutors. The rate of the tax would be a function of both quantity and type of pollutant. This tax has been used successfully in the Ruhr Valley of Germany for sometime. If such a tax was levied by the State as an excise tax for the use of public waters, it would be constitutional. If such an excise tax was levied by the Federal Government, but limited to navigable waterways, it too would be constitutionally sound.

2. There should be no state, real or personal property tax on water pollution abatement facilities, nor, should such facilities be used to determine a corporation's

value for excise or franchise taxation.

3. A corporation should have the option to treat water pollution abatement facilities as a business expense under Section 162 of the Internal Revenue Code of 1954. This could be done without denying the investment credit under Sections 38 and 46.

4. Section 6111.05 of the Ohio Revised Code should be modified to require full public disclosure of all pollution sources.

5. Communities with water and sewage charges substantially below the national average should raise their rates immediately and apply the proceeds to pollution abatement facilities.

6. Communities with inadequate sewage treatment facilities should not be allowed to expand the size of their populations. No building permits should be authorized until such facilities are of acceptable standards.

7. The water quality standards of the Ohio Water Pollution Control Board should be repudiated for failure to meet the standards set forth in 33 United States Code Section 466 (b).

8. The revised conclusions and recommendations of the conferees as stated August 12, 1965, together with the recommendations of the Lake Erie Program Office of the Federal Water Pollution Control Administration should be

implemented.

If these recommendations are carried out, we may have a chance of seeing pure water in Lake Erie and its tributaries within the lifetime of some of the people in this room.

If we continue to talk about goals of water with 2 mg/liter of oxygen in 1975, we might as well all give up. The basic problem, I reiterate, is one of philosophy. If we accept as a guiding principle the concept that no one has the right to pollute our waters, at any time, for any reason, we can develop programs necessary to end pollution. The remedies will be costly and we will all have to pay the charge, but there is no other way. Thank you. (Applause)

CHAIRMAN STEIN: Thank you, Professor Reitze.

I would like to point out several things: One, that in addition to the requirements set forth by the conferees, there was a time schedule set forth specifically for improvements to be made in each State and this is all set forth in detail. A lot of these plans are to be completed in 1970 and 1971. Obviously, until the plans are completed you are not going to see the improvement.

Now, I have several suggestions: While all these statements are indeed appreciated, I would like to point out what the function of this panel here is, and I speak representing the conferees. We have set up an action program to abate pollution. We have a time schedule and requirements to do it. There may be a lot of suggestions which can improve water pollution control, such as changing the law, the tax structure, economic consensus, and so forth. I think most of the people at this table have been in long discussions in other forums on that.

But I would suggest that any really effective action in these areas would require the placing of this before another forum. The only mandate that we have is to follow out the conclusions of the conference and to see that we are moving ahead. Again, I make a plea to you, because this is a new aspect of water pollution control that I think we are faced with throughout the Great Lakes. I think both in Lake Michigan and in Lake Erie we are probably right in the throes of the biggest municipal and industrial waste cleanup that I have ever experienced in this country, and I think that we have ever had.

Now, while we are in the midst of this cleanup, what appears to be happening is we are getting the same kind of criticism -- and, by the way, I will fight to the death for your right to make this criticism -- this we have gotten before -- but I would suggest that the way to be productive is to find out if we are meeting that schedule.

Now, the analogy I used before -- and let me try to use it again -- if we have a congested highway, and a two-lane road, and we decide to build one of these beltways or superhighways to alleviate the traffic, you can start throwing the dirt, grading, etc. But until you cut that ribbon and the cars get on the superhighway, you are going to have the same traffic jam on the old road.

Now, I don't think anyone reasonably at this table expected that we were going to have spectacular results or even significant results until these plans got on line, and the time schedule has to be had in mind.

For example, Michigan -- we had construction of all industrial and remedial facilities to be completed by January 1970. In Indiana, they were to be completed by December of 1968. In Ohio, construction of all remedial facilities by 1971, with the exception of the Cleveland Westerly Plant completed by December of 1971. In Pennsylvania, construction of all remedial facilities to be completed by December 1970. In New York, construction of all remedial facilities completed by January 1971, with the exception of Republic Steel at Buffalo, New York, which is to be completed by July 1971.

These conclusions were arrived at after extensive analysis and discussion. As you can see, none of these dates really have arrived yet, and to expect a change in the water conditions which we all agree had to be improved before these plans and these improvements go into shape, I think is not looking at reality.

What we had to do -- and maybe the conferees were wrong in this -- was set up a reasonable time schedule. We all think that the time schedule was pretty tight -- and if you don't believe us, ask some of the cities and the industries concerned -- but I don't think that we can really answer the question of why the water isn't getting any better before the plants go into operation, because it is not going to get any better before the plants get into operation. This is what this panel is here to try to do here today.

Are there any other comments or questions? If not, as you know, we are graced with several large cities in and around Lake Erie contributing their effluent waters which either flow into the lake directly or indirectly, and I am sure we will hear from Cleveland in a little. But we also have another large city on the lake, Detroit, and I wonder if I could call on Mr. Oeming for a presentation from Detroit.

MR. OEMING: Yes, I would like to, at this time, call on Mr. G. Remus, of the Detroit Water Board, to present a statement.

MR. REMUS: Conferees. I think, as you know, that the Sheraton-Cleveland Hotel has got a notice down there that the meeting is in the Grand Ballroom. That is where we were for a while until we woke up.

My purpose here is to explain what progress we have made in the program that we, in cooperation with the area of Detroit, and with the Water Resources Commission of Michigan, worked out. The basic program involved 114 million dollars worth of work. It involved improvement in treatment, some expansion of the system, and it involved taking care of the area.

We, of course, had to reduce the solids we put in the river. We had to reduce the BOD loading, and those nuisances of oil, phenols, and so forth, all were included. A formal contract was signed, which had been approved by the City of Detroit, which I think is unusual in that it documents from the Rouge River north upstream, so that the Detroit municipal water services operation would be responsible for meeting the new standards and also putting the interceptor in the area to do the crucial job.

It is unusual, I think, in that there is no industry in that area that discharges directly into the Detroit River. All of it discharges into the public system, and, as such, complicates in one way but helps in another.

On each phase of the operations that we have, I would just like to briefly comment where we are. We have quite a lengthy report here that we have presented to the conferees, but I do not wish to pursue that.

CHAIRMAN STEIN: Mr. Remus, without objection, that report will appear in the record as if read in its entirety. (The above-mentioned report follows.)

MR. REMUS: Presented herein is a brief summary of progress to date by the Detroit Metropolitan Water Service on its Detroit Regional Watershed Pollution Control Program launched in September 1966.

The Detroit Metropolitan Water Services Wastewater Disposal System currently serves approximately 3,000,000 persons living in fifty-four communities, including Detroit. The system's service area is presently about 360 square miles. The Detroit Metropolitan Water Services Wastewater Disposal Plant processes an average of 700 million gallons of sewage per day.

I. Wastewater Plant

A. Advanced Treatment

1. Test Facility

Expenditures to date - $558,713.67

a. Demonstration Project

With the assistance of a $300,000 Federal Grant offer, a 200 gpm advanced treatment test facility has been constructed and placed in operation. The activated sludge portion was placed in service in September 1967, and the trickling filter portion in May 1968. Federal participation in the project is scheduled to continue until December 1969. Project operating costs for the next eighteen months are estimated at $200,000.

The primary objective of the test facility operation is to obtain proven design information for an economically feasible process for removal and/or reduction of suspended solids, BOD, phenol, oils, bacteria and 80 per cent of the incoming dissolved orthophosphates in accordance with our May 19, 1966, Stipulation Agreement with the Michigan Water Resources Commission.

Other objectives are to determine: the comparative economies of the activated sludge and trickling filter processes; the suitability of various sludge disposal methods for phosphate removal; and the development of practical uses for industrial wastes.

The variety of tests conducted to date on activated sludge without chemical additives have not demonstrated any potential for consistent phosphate removal, especially insofar as the dissolved orthophosphate fraction is concerned. Total phosphate removals were generally about 50 per cent, but the dissolved fraction showed bleedback tendencies.

Detroit is one of the world's centers of the metal working industry and for many years we have known that when a slug of ferrous iron appeared in the wastewater at the plant, the phosphate content dropped to a low level. Laboratory studies were made using various iron salts, and it was learned that waste ferrous chloride from the steel industry, some of which is being discharged into the river, is very effective in removing phosphate from Detroit wastewater. Accordingly, the use of pickle liquor for phosphate removal was made part of the demonstration project.

Pickling liquor (ferrous chloride) has been added to the wastewater in a pilot activated sludge process for approximately two months. The indications are that better than 80 per cent of the total phosphate is being removed. The final effluent concentration of orthophosphate is from 0.4 to 0.7 mg/l of P. This does not meet our stipulation of 80 per cent removal of orthophosphate; however, the incoming orthophosphate is extremely low, averaging from 1.1 to 2.0 mg/l of P. This makes an 80 per cent removal much more difficult to obtain.

In the final analysis, it is the phosphorous content of the effluent that really matters -- not the per cent removal. Therefore, if the waste pickle liquor treatment process were to be incorporated into the plant design, a two-fold objective would be accomplished:

1. Lake Erie would be deprived of most of the phosphates from the municipal plant, and

2. Industry would not be compelled to develop and construct treatment devices for their waste pickle liquor.

With or without pickling liquor, the activated sludge process has demonstrated the capability of consistent high removals or reduction of suspended solids, BOD, and TOC.

The plastic media trickling filter is in the "shakedown" stage. No data of consequence has been obtained during the first month of operation.

Phenol reduction continues to be studied and analyzed.

Dewatering and incineration of the waste sludge (primary activated) will be under study and analysis in the near future.

b. Deep Tank Aeration

Due to ever-increasing population densities and housing needs in urban areas, it is known that every effort will have to be made to expand vertically as well as laterally in the future, and this concept applies to wastewater plants as well.

Therefore one of the 25 feet deep sludge holding tanks is being temporarily converted to a demonstration aeration tank to study the feasibility of using shallow submergence aeration systems on tanks of depths of 30 feet or more.

The equipment for this test is installed and ready for operation.

2. Allied Activities

a. Detergent and Soap Industry

At a recent meeting of the Industry/Government Joint Task Force on Eutrophication Research at the Detroit Wastewater Treatment Plant, where they reviewed our pollution control program and our pilot research plant for phosphate removal, the detergent and soap manufacturers stated that they were searching diligently for a substitute for phosphate in detergents.

3. Future Construction

Within approximately one year, it is expected that sufficient design and cost information will have been derived to enable proceeding with the design and construction of the first segments of the advanced treatment facilities. It is probable the method will involve a chemical-biological process.

Provided that 55 per cent Federal and 25 per cent state grant assistance is forthcoming in sufficient volume at an early date, the first full-scale segment may have a capacity of 100 to 200 cfs. and may cost approximately $70 million for biological-chemical treatment tanks, final settling tanks, pumping facilities, discharge and chlorination conduits and sludge disposal facilities. Upon satisfactory operation of the initial units for approximately two years, other segments would be added to bring the advanced treatment capacity up to plant load requirements.

B. Expansion

Due to enlargement of the service area of the system, higher per capita water usage and interception of a greater percentage of storm runoff, it will be necessary to not only provide advanced treatment but to expand the basic capacity of the treatment works.

1. Site

We are in the process of acquiring approximately 27 acres of adjoining residential area to add to our present 72 acre site. Approximately 80 per cent of the properties have already been acquired by negotiated purchase and demolition is in progress. Acquisition costs are estimated at $2.5 million.

2. Construction

Tunnels, conduits, primary tanks, vacuum filters and incinerators are being added to increase the basic capacity of the plant by approximately one-third.

Approximately $2 million of work is under construction and another $0.5 million will be under construction prior to June 30, 1968.

An application for 55 per cent and 25 per cent state grant funds has been filed for approximately $35 million of expansion and improvement work to start prior to June 30, 1969. Included in the work is the installation of two fly ash collectors, which when installed will provide for 100 per cent air pollution control from all incinerators.

C. Product Reuse

Due to the ready availability and economy of purified Great Lakes waters, there is currently no market for primary effluent nor is there expected to be any market for secondary effluent.

However, in addition to the effluent, a wastewater plant produces two other waste products: namely, hot exhaust gases and ash (or filter cake).

The exhaust gases are cleaned with a wet scrubber, and this hot scrubber water is now processed through an in-plant system for plant housekeeping, filter cleaning and scum processing.

Pilot plant studies have been made by a cement company (Peerless Division of American Cement Corporation) and others using Detroit's sewage filter cake (or incinerator ash) with powerhouse fly ash to produce a light weight aggregate. The product produced is of superior quality. The cement company is seriously considering manufacturing this product because there is a tremendous market for light weight aggregate. There is also the possibility that sewage sludges can be used in place of filter cake in a rotary kiln.

D. Design Progress

Approximately $300,000 has been expended to date for engineering and technical services (exclusive of test facility) toward design of required treatment plant facilities.

1. Outfall diffuser - contract bids opened.

2. Plant tunnels (raw and settled flow) - contract documents complete.

3. Screenings Disposal - under construction.

4. Primary tanks (two each) - design approximately 30 per cent complete, including soil borings.

5. Scum disposal - alternate processes investigated. Preliminary layouts prepared.

6. Sludge disposal - alternate processes investigated. Preliminary drawings prepared for vacuum filtration, incineration and pneumatic ash disposal.

7. Intermediate lift station - alternate layouts prepared.

8. Biological process - site arrangement plans prepared.

9. Final settling tanks - scale model tests completed. Preliminary plans in process of being prepared.

10. Chlorine contact chamber and effluent conduit - preliminary plans prepared.

11. Rouge outfall -- scale model built. Hydraulic testing started.

12. Heating and ventilating - cost studies prepared.

13. Electrical and instrumentation - studies underway.

14. Site improvements - preliminary planning underway.

II. Combined Sewer Overflow Control

With the assistance of a $1 million Federal grant offer, DMWS is currently constructing a $2,113,000 sewer system monitoring and remote control network as a demonstration project for improving combined sewer overflow quality. Other work to improve the system is also proceeding concurrently without Federal financial assistance.

A. Objectives

The storm overflows from the system are tributary to the Detroit and Rouge Rivers. There are approximately seventy points where overflow could occur. Presently the exact number of spills, their duration and volume and the quality thereof are not known.

The primary objective of this project is to reduce stream pollution from combined sewer overflows by reducing the number and duration of spills and by controlling the quality of that portion which of necessity must be spilled during heavy rainstorms. This is to be accomplished by practicing storm anticipation and thereby in effect gaining additional temporary stormwater "storage" or retention in the system. The plan is to lower the liquid level (hydraulic gradient) to the maximum degree possible by coordinated pumpdowns at the wastewater plant and sanitary pumping stations prior to a storm and to hold the level as low and as long as possible so as to intercept the first flush of the storm and as much of the entire storm as possible. To do this properly requires instantaneous knowledge of the behavior of the system, the storm and the characteristics of the sewage at all times.

The work consists of the furnishing and installation of liquid level sensing devices at numerous locations throughout the system, proximity switches on all backwater gates and diversion devices to denote open or closed position, rainfall intensity and accumulation gauges at numerous locations throughout the metropolitan area, sewage sampling devices at critical locations, remote controlled sluice gates at several locations for flow manipulation and throttling, flow measurement devices, remote control switch gear at the pumping stations and the control center as well as all related electrical, mechanical and structural work. The work also includes operation of the sewage disposal system to maximise pollution control and maintenance of the equipment installed under this project.

The second objective of the project is to collect data on the behavior of flow in the sewer and interceptor system which will aid in the design of more adequate sewers and interceptor systems in the future.

The work will include analysis of samples, interpretation of data, mathematical computations, establishment of emperical formulas for use in computer programming, and other work required to prepare the information for use in future designs.

B. Construction

1. System Monitoring and Remote Control

The monitoring equipment and data logger for the initial phase of the project have been delivered and are being installed. It is anticipated that one year will be required to complete the installation and place the system in initial operation.

A contract for the furnishing and installation of power driven regulator gates and "sluicing gates" has been advertised. It is anticipated that this work will also be completed within one year.

A program of sewage sample collection (manual) and analysis has been in operation for some time. The sample collection-analysis program is providing background information on the quality and characteristics of various combined sewer outfalls.

Automatic sampling apparatus is in the process of being procured to enable initiation of a 24-hour sampling program. Three vehicles have also been ordered to provide transportation for the sample collection crews.

2. Additions and Improvements to the Sewerage System

a. Dolson Backwater Gates (work completed)

Project Cost - $78,190 (33 per cent Federal)

In our continuing program to protect the interceptor system from flooding out from high river levels, backwater gates were added to a sewer outlet on the Rouge River south of Schoolcraft Road.

b. Leib and Helen Regulator Additions and Improvements (work completed)

Project Cost - $213,322 (33 per cent Federal)

To accommodate increased loads emanating from Oakland County through the Dequindre Road interceptor, the capacity of the Leib Regulator on the Detroit River was doubled.

To make the Helen regulator more responsive to available Detroit River interceptor capacity, the regulator sensing and operating system was modified and rearranged.

c. Oakwood Pumping Station

Project Cost - $105,131.86 (33 per cent Federal)

Twenty-five per cent more sanitary pumping capacity is being added to the Oakwood Pumping Station. The pumps are scheduled to be in service in November 1968.

Due to the station's proximity to nearby oil refineries along the Rouge River, a neoprene belt type oil skimmer has been added to the pumping station wet well. Startup testing is underway.

d. Belle Isle (work completed)

Project Cost - $268,053 (33 per cent Federal)

All sanitary wastes from Belle Isle are now pumped to the mainland for treatment. The existing Belle Isle Treatment Plant has been modified and converted to a stormwater retention and treatment facility.

e. Sewer Program

A program of constructing additions, improvements, replacements and modifications to the system of laterals, trunk sewers and storm relief sewers is being performed at the rate of several million dollars per year.

C. Operation

1. Present

a. Regulator Surveillance and Adjustment

All regulators and backwater gates are inspected and serviced regularly and after every storm by a four-man crew.

Regulator float settings have been reviewed and field adjustments made where required to optimize utilization of all available interceptor capacity by present operation methods.

b. Preventive Maintenance Inspection

The condition of the interior of the Detroit River interceptor, the combined sewer overflow outfalls and some major combined sewers is being inspected preparatory to formulating a renovation program to complement other work to be performed toward control of combined sewer overflows.

c. Related Activities

Studies and reports of others such as those of the U.S. Army Corps of Engineers, the Federal Water Pollution Control Administration, and the American Society of Civil Engineers are being reviewed for information relative to quality of combined sewer overflow, storm drainage and rainfall as it pertains to the local situation.

2. Future

a. Following completion of the installation of the System Monitoring and Remote Control Network, much of the surveillance and operation of the system will be conducted from a central location.

As more knowledge of the system behavior is derived through subsequent operation, many of the operating functions will be adapted to direct computer control.

Quality collection, analysis and control will be mechanized to the maximum possible degree.

III. Regional Interceptor System

Currently, DMWS serves all or portions of 54 communities in Wayne, Oakland, and Macomb Counties.

A. Service Area Expansion

The long range objective of DMWS is to provide wastewater disposal service for all of Wayne, Oakland, Macomb, Monroe, Washtenaw and St. Clair Counties in an orderly and systematic manner.

Of immediate concern is the provision of wastewater interceptor facilities for the Clinton River drainage basin. This service is essential for the following reasons:

(1) The waste load on the Clinton River must be reduced to protect our Belle Isle water supply intake.

(2) The region (and Nation) will benefit from single unified administration and operation of all pollution control efforts in the region.

(3) The area will financially benefit from the economy of large scale operations.

Accordingly, DMWS has signed service agreements for all of Macomb County and all except the westerly portions of Oakland County.

Communities to which service is to be extended initially are:

Macomb County
Chesterfield Township
Clinton Township
Fraser
Harrison Township
Macomb Township
Sterling Township
Utica

Oakland County
Avon Township
Orion Township
Pontiac Township
Waterford Township
West Bloomfield Township

Currently, DMWS is negotiating for initial service to three other communities in Macomb County: Mt. Clemens, Shelby Township, and Warren. It is also expected that several other communities from Oakland County will soon be incorporated into the initial phase of the program.

DMWS has had preliminary discussions with Livingston, Washtenaw and Monroe Counties relative to service by the proposed Huron River-Hannan Road Interceptor System. Preliminary studies indicate that this system would serve the remaining portions of Oakland County (except that area outside the drainage basin), portions of Livingston County, all of Washtenaw County, the remaining portions of

Wayne County not presently served by DMWS, and portions of Lenawee County.

B. Construction Program

Approximately $65 million is to be expended in the next two years for the initial construction of the Oakland-Macomb Interceptor System. Soil boring and aerial photogrammetric data are currently being collected. The basic design of the system has been completed.

C. Future Construction

The design of the North Interceptor, the major outlet for the Oakland-Macomb Interceptor System and other systems in Oakland and Macomb Counties, is in the developmental stage. Preliminary cost estimates for this facility indicate an expenditure of approximately $60 million. This facility is expected to be in operation before 1975.

A preliminary estimate indicates that at least $200 million would be required for construction of portions of the Huron River-Hannan Road Interceptor System, including the Huron River Regional Wastewater Plant, in the next 20 to 25 years.

IV. Industrial Waste Control

A. Scope

The policy of the Detroit Metropolitan Water Service is to work cooperatively with industry toward the solution of our mutual problems.

The following numbers of companies which discharge to our sewer system have been contacted:

Oil Survey	- 297
Acid Usage	- 142
Heat Treating Industry	- 12
Pharmaceutical Industry	- 2
Fried Foods Industry	- 8
Total Personal Visits	- 113
Total Companies Contacted	- 574

Of those contacted, the following have instituted major treatment facilities:

General Motors Corporation	Chrysler Corporation
Ternstedt Division	Mound Road Engine Plant
Chevrolet Gear and Axle Plant	Eldon Avenue Axle Plant
Chevrolet Bumper Plant	Detroit Universal Plant

Industrial waste control installations, now operating or being built by private industry in the Detroit area and whose effluent enters our system, represent a cost of over $8 million. All of these operations have been voluntary and were instituted by industry after the nature of our industrial waste control problem was made clear.

In addition, the following companies have made extensive surveys and are studying methods for the best ways of treating their effluent:

General Motors Corporation	McLouth Steel Corporation
Detroit Diesel Engine Division	Ford Motor Company
Cadillac Motor Car Division	Livonia Plant

DMWS is actively working with Ford Motor Company to solve their phenol discharge problem. DMWS has also arranged for the Scott Paper Company plant to discharge the paper mill waste into our system.

In our oil survey, it was found that 27 companies reported 71.5 per cent of the unaccounted-for oil. Accordingly, our waste oil problem is one of getting these large contributors to remove this waste oil from their effluent.

Personal visits have been made by our staff to 63 plants. It is estimated that 50 additional companies have been visited for reasons apart from the above-mentioned industry surveys.

Thus, a total of 574 companies have been contacted with respect to the control of industrial waste. From this list of contacts, there has evolved a hard core roster of chronic contributors of acid and oil. We are actively working with the large oil contributors and we make a continuing survey of the acid contribution of the companies whose records are poor in this respect.

B. Proposed Follow-up

Liquid wastes generated in the Detroit Metropolitan Area are influenced by the fact that Detroit is the automotive center of the world. This concentration of the metalworking industry contributes oil, acid and heavy metals out of proportion to the population when compared with other American cities. Major sources of these wastes have been determined, but their full evaluation remains to be accomplished. Contacts with Detroit industries have revealed a paucity of effluent data. Expressed interest of Detroit Metropolitan Water Services has already resulted in effluent surveys and others are being planned. Several of the industries have requested assistance of the Industrial Wastes Control Unit in the organization and conduct of these surveys. This follow-up work is considered a most important element in the successful prosecution of the Industrial Wastes Control Program of Detroit Metropolitan Water Service.

C. Forthcoming Work

1. Continue conferences with industry and extend into suburban areas.

2. Maintain an organized follow-up on pollution abatement programs with those industries known to create significant liquid wastes.

3. Collaborate with industry in the conduct of comprehensive industrial waste surveys in an effort to characterize wastes and to determine respective volumes.

4. Develop an effective industrial effluent

monitoring system in cooperation with industry.

5. Accumulate data to serve as basis for developing industrial waste surcharge schedules.

6. Coordinate industrial waste findings with pilot plant investigational research at Detroit Wastewater Treatment Plant.

7. Revise "Standards and Regulations Controlling the Discharge of Industrial or Commercial Type Wastes into the Detroit Sewer System."

V. Community Action

A. Keep Detroit Beautiful Committee

The mayor's Keep Detroit Beautiful Committee has launched a vigorous campaign this spring to enlist the help of all citizens in keeping our streets and alleys free of litter and dirt. A recent study by our department reveals that the dirt and debris which washes off the roads into the combined sewer system has a costly impact upon those we serve.

B. United Automobile Workers

The UAW has been of invaluable assistance in alerting the people of this area to the problems and costs of pollution control and in striving for the necessary legislation and funding.

C. Marinas and Boats

Recent State legislation on the control of waste and litter involving boats and marinas has prompted preliminary design work on sanitary waste disposal facilities for the city-owned marinas. Such facilities are to be in operation by 1970. The Province of Ontario has passed laws similar to Michigan's for the control of pollution from pleasure boats.

D. City Departments and Agencies

A unified and expanded street and alley cleanup program was recently initiated by the major city departments. This will materially reduce the solids flushed into the combined sewer system during a storm. (End prepared report.)

I will only spend a few minutes to point to the various things that we are doing, and in the order that they appear in the report.

At the present time, we have 54 communities besides Detroit on the system, about three million people. An additional twelve are under contract for which construction is going forth.

We have about 360 square miles of service area to be responsible for. To attack this problem, we had multiple things to do: one is to find out exactly what our improved treatment had to be, what our expansion of the system had to amount to, what we were going to do about stormflow to do the best we could; and we had to put this all into some sort of practical balance so that we could plea to the city fathers to get approval so that we could do the financing.

The wastewater treatment was improved, but the fact remained that there were certain things we knew and there were others we did not know, principally regarding the phosphate removal aspects. In cooperation with grants that we have received, we have built a wastewater plant that has been in operation now some six months. Briefly, it did not improve the phosphate removal situation. However, working that in conjunction with pickling acid from our steel mills, we have been able to get in excess of 80 per cent total phosphate removal. Our stipulation, of course, is to orthophosphate removal and we may come to the Water Resources Commission for some adjustment on our contract on that in light of the information that is being developed.

We have operated a plant for 21 days where we met the 80 per cent removal factor by the fact that the conglommeration of sewage came in there with a pretty good sludge of pickling acid and a combination of this -- for lack of better English -- mess took the phosphate removal out -- or took the phosphate out to the extent that total figures were all right.

Now, what I am saying here is that in the last analysis, the combination of chemical and bacteriological treatment seems to do the job. In our test station, which has now been in operation for two months, we have been getting the 80 per cent on total phosphate removal. We will operate yet another three or four months on that to make sure we have all aspects evaluated.

We have explored the aspect of working with industry on this, and we think there are two very important factors that are promising as far as the entire area is concerned. If this method of handling the phosphate removal can be finalized so that we can bet millions of dollars on it, then, of course, our municipal plant will be handling all of the waste for the area, and indirectly by that method industry will be getting the help it needs in their complicated problem, and they will not have to at least in the area we serve build their own treatment plants to get rid of those types of wastes.

We have some aeration problems, and we have some tanks under test on that. We have a working arrangement with the detergent industry, and I believe they are now becoming aware of the fact that the total cost of the detergents on the shelf is what it takes, and we hope that the prevention aspects there will develop.

We have committed a lot of construction in the plant, such as: we have cleared 27 acres where 198 homes were taken off, plus four industries, for the space we need for the plant improvement -- that is substantially complete.

We have committed some adjustments to the conduits for sewage handling in the present site for the purpose of being able to adjust increased plant capacity when it comes.

We have committed and have installed additional filters and additional burning equipment, and we are bound right now in the business of committing money to do additional work on the basis of 33 per cent participation, when in the near future we hope to have the 80 per cent or 85 per cent participation by combination of Federal and State help.

The reason we committed as much money as we did to get this basic work done is that it is those incidental things that take so much time, so that when you go into major construction that you have to do anyway, and we didn't want to postpone our operations any further.

A couple of interesting sidelights: One I mentioned was that pickling has benefit which was better than we anticipated. Another one, we have extended review with Peerless Cement and they have concluded that the filter cake can be burned in conjunction with fly ash from precipitators of the power companies at a temperature in the range of 22 to 24 hundred degrees, and you make a very effective light weight aggregate. We hope that Curtis Cement will put the plant in, and if they don't we probably will.

The design of the system is such that we will have major construction underway as soon as the Federal and State money becomes available.

On the combined sewer overflow problem, I just briefly want to mention that we have received $1 million from the Federal Government which we matched with the idea of sort of escalating a storm sewer across the city of Detroit. Our system is made up with a multiple of 12, 16 and 17 foot stormflow conduits. We are operating those at an elevation that is about 35 feet below the river level for the purpose of keeping those empty so the smaller storms that go across do not cause our regulators to function and dump directly into the river.

We have been able to take those spills down a considerable number of times. I think it was 26 times in the last year that we had spills in the river which was roughly half of what we had the year prior. You hate to use that kind of data, however, because the weather man might make a liar out of me in the morning.

The principal thing we are concentrating on, on the stormflow, is that we would put in and we are now having installed a good portion of the controls on our stormflow pumping station, and operate our regulators in such a way that the first flush of the storm will go directly to the plant and then it will be bypassed into the river, and that way we will catch the dirty sludge that lays in these large interceptors.

The second aspect is: we have, in cooperation with the Keep Detroit Beautiful Committee, a rather extensive program whereby we hope to cut down the amount of dirt from alleys and streets that gets into our catch basins and into our sewers. The tonnage on that is very large. We have had a great deal of evaluation of that, and we believe we can cut that in half. The home owners, I think, should know they can take their rubbish from in front of their house and get it disposed of via truck in rubbish containers at about $20 a ton -- $20 to $27 is the range we found. Also it found it is $120 a ton via the sewage system, and, as such, we are not only keeping Detroit clean if we follow this route, but we are saving a lot of money.

Those types of figures do make impressions on committees that have been working on it. All of the departments of the city have been working on it, and we think that will help considerably.

There are details in the report on what type of controls we are installing on our storm system, what type of gates we are installing or have installed and I will not read those.

We have another aspect of our program that I would like to point out that is underway, and I am not talking from what we are going to do. The points I am mentioning here are the ones that are being done. We are expanding the system. There still are effluents which empty into the Detroit River by some route, and if you are going to take the central city and improve our treatment and do not do anything about the outlying district, you are either going to stop development or you will not be making any sum total improvement.

The twelve communities that we are now doing construction work for, where we build the sewage plant outside the city of Detroit, to go into those areas to collect the wastes, the sum total of that construction is about $60 million. There are about $8 million under construction now, where the contracts have been awarded.

One of the brightest spots we have found is the industrial prevention, pollution prevention. I mentioned the aspect of pollution prevention as far as getting it off of the streets in our system, and hopefully we will gradually reduce that. But in our dealing with industry, we have to date worked with 574 different companies that we suspect or now know have been adding to the complications of our sewage system. Of those, 297 were on oil survey; 142 were acid usage; 12 were heat treating industry; two were the pharmaceutical industry; eight, the fried foods industry; and 113 miscellaneous. I think it is of interest that we are getting a very good cooperation from industry.

The pressure that Murray Stein and his team have put on apparently is getting some results along that line. I never thought I would give him that acknowledgment because we started a long, long ways apart, and we are getting closer every day.

The principal companies that have really responded were such as General Motors; Chrysler; Ford; the people at -- well, Scott Paper -- there is a large waste problem which they could not correct in their own property so we are taking their waste now, and they are paying us extra which helps in our operation. The bill is a mere $300 a day.

The point that I want to make is that on this industrial pollution prevention is that indirectly it helps industry a great deal; because if we can get Federal financing, State financing, together with our local financing, and take the industrial wastes from those plants thereby cutting down if not eliminating the construction they have to make for their wastes, they are by that method getting tax relief for their problem. This took us a couple of years to work out, and we believe it is the best answer that is on the market today for that particularly ticklish problem and we would oppose any change because we have this one working now.

The problems we have, then, in brief are based on the fact that we think we are close to the final answer that we will need on our treatment process. It will be a combination of bacteria reduction and chemical precipitation if you want to use that kind of language. We know we have the expansion of the system developing. We have a better control of our stormflow situation, but I would not want to mislead anyone in thinking that that problem is solved.

We do not, of course -- I want to repeat -- subscribe to this business of separating sewers for two major reasons: one is we are not sure that is the final answer on the basis of dirt that runs off of the streets as far as pollution is concerned, but more so in a city like Detroit it is impractical. There is $1.7 billion to do the public part of it to say nothing of what the home owner would have to do and we would have the streets dug up until the year 2020 to get that kind of separation, so the best answer has to be found.

We are taking steps on it. We have now reduced the amount of dirt that comes in the river now in storms already, and we hope in a systematic way to resolve this to a better solution.

Now, on the report that I gave the conferees there is a summarization of our 10-point program. It involved the three I mentioned: stormflow, the improved treatment and expansion of system.

There are some additional ones that are, however, necessary. One is, I think you have to recognize, whether you like it or not, that the water supply and the protection of that supply is one economic problem. We handle it in two different accounts, but we know if we misapply our efforts on one it will affect the other one.

Another point I mentioned here is this pollution prevention which I think should be attacked on three major fronts, which I would like to report. One is industry; the second is with the home owner; and the third is with the detergent industry, who, after all are the ones that are phosphating -- the principal people that are phosphating our lake.

There are other things, such as boat marinas. There are 500,000 people on the river in the summertime. Most of them are in marinas which have inadequate circulation of water, which usually have little rubbish control, equipment and very little sanitary facilities.

The State of Michigan has adopted a law, as has Ontario, Canada. In Michigan, in 1970, the larger pleasure boats have to have appropriate facilities on them. We have, however, some very serious binds. I would like to point out that we have had very good cooperation from, as I mentioned, the Keep Detroit Beautiful Committee and the United Auto Workers. The first reaction on boats has died out, and the marinas are working very cooperativel y on what has to be done.

The city government of Detroit has approved a $114,000,000 commitment. If you look at that folder, that adds up to $922,000,000 by the year 2000, the normal projection of that system.

We have our financing done to this extent: that the money that we need is in this form: of $114,000,000 we have about $19,000,000 in cash on short-term investment, which we are using for these starts here. We have approval for the bond money; when the city fathers approved this program they approved the money. Nobody in their right mind, however, would go and commit $114,000,000 worth of work with the probability of 80 per cent or 85 per cent being available from the outside, and that is what we are awaiting, the point being that the Federal Government is now changing its financing scheme.

The State of Michigan hopefully will pass that $335,000,000 bond issue which will make the State's participation whole. If we are to really make this program move on the schedule that we have laid forth here and which we have all the basic work done on, then this finalization of the funds has to be made promptly. I can't emphasize that rapidly enough because in most municipalities, as in ours, you cannot get city funds appropriated except under a set of very precise conditions. By the time that has been set, the Federal agency changes its rules, and again you are out of step, so this boogie-woogie financing has to stop if we are going to make progress. Thank you. (Applause)

CHAIRMAN STEIN: Thank you, Mr. Remus.

As many of you know, Mr. Remus is the head of one of the largest water supply and waste-disposal systems of the country: the metropolitan area of Detroit. He has been the past president of the American Water Works Association which is meeting here today. Jerry, there may be some questions or comments. The conferees may have a question to ask you.

I just have one slight comment. I never thought I would like to see the day when Jerry Remus would be guilty of understatement, but he today said we started some distance apart. That was an understatement. (Laughter)

Are there any comments or questions?

MR. POSTON: I would like to comment that I think Mr. Remus gave a very excellent report of the activities, and they certainly have had a lot of them in connection with the abatement of pollution in the Detroit area.

My question is: Are you essentially on the time schedule at the present?

MR. REMUS: On parts of it we are ahead. The aspect of getting the major additional treatment completed depends entirely on how fast this money can be made available, and even then it is a very tight schedule. I would think that we are somewhat behind on the improved-treatment aspects in its entirety. Certain sections of the plant changes are being made and those are on schedule, but to finalize that last step I think is going to be a very tight schedule.

CHAIRMAN STEIN: Any other comments or questions?

MR. METZLER: Detroit is very fortunate to have one of the most experienced utility managers in the country in your position.

MR. REMUS: Thank you. I wonder what that is going to cost me.

MR. METZLER: Well, my question really is -- perhaps this is because I have come into the picture a little later, Jerry -- but what kind of removals now are we talking about here in the event the financing doesn't become available? Are you hopeful that you can get 80 per cent phosphate removal perhaps or in this range?

MR. REMUS: Very close to that. On the basis of the test operations of the test station, which is a good size test station, we have done it now for about two months; and by a combination of circumstances, it isn't a full plant for twenty-one days, but we had to find out by the reverse process what really happened. We didn't know, but we concluded that it was a rather systematic deposit of pickling acids rather than in large solution entering the system.

MR. METZLER: Can you give me a general idea of what the added costs are for phosphate removal as you are putting them in here in terms of percentage of your overall cost?

MR. REMUS: Well, I cannot apply that to phosphate alone, but we are expecting that our operating costs will double at least.

MR. METZLER: The reason I asked the question, it leads to my next one: Do you feel any qualms about putting in a lot of -- well, making a major financial commitment for phosphate removal with the possibility that the detergent industry is going to change to something else, or have you pretty well sold yourselves that they cannot?

MR. REMUS: Well, hopefully we are handling this in such a way that that will not break our back either way, the reason being that most of what we have committed ourselves to now we would do in any event. Part of this phosphate removal thing -- to answer that precisely -- I wouldn't want to answer that right now, because I don't know the answer. But before the final big slug of money is committed, we will have to have a better evaluation, because I think you people are practical enough to know that unless we are sure of what we are going to get as the result, you cannot commit that type of money.

CHAIRMAN STEIN: I would like to make one more comment: Since this program had started, Michigan, the Federal Government and the Detroit area zeroed in on what the objectives of the program are. Mr. Remus has moved on the abatement time schedule in really an expeditious manner, and I would commend some of the experience in Detroit to some of the other major cities, or even the smaller ones that are considering facing the same problems.

I do think that the approach that Mr. Remus has used and the evaluations that he has used have been outstanding and present a real expeditious and sensible approach to the problem. I certainly am encouraged because I think we are finding a major city moving toward a solution of a pollution problem in an exemplary fashion that is certainly satisfactory, I am pretty sure, to the State people and certainly to the Federal people. I think we have to meet some of these difficult problems one at a time.

MR. POOLE: Mr. Chairman.

CHAIRMAN STEIN: Yes, Mr. Poole.

MR. POOLE: Mr. Remus, I just want to be sure that I understood you correctly on one issue, and that is: you are saying that Detroit's rate of progress from here on is going to depend basically on the availability of Federal and State grant funds, am I correct?

MR. REMUS: That is correct.

The bind in our program now is the money. I would like to make one other explanatory statement here. The responsibility of the department I represent is from the Rouge River up, and we have a lot of work to do in southwest Wayne County where we have a multiple of small sewer systems, where industry discharges directly into the river, and we are not responsible for that. But we are trying to work out a program with Regional Planning and with Wayne County and with Washtenaw and Monroe Counties, to see if we can't handle that on an area-wide basis; but the progress isn't very good on that right now.

CHAIRMAN STEIN: Any other comments or questions? If not, thank you very much for your contribution.

At this point, may we hear from Cleveland and I'd like to call on Mr. George Eagle?

MR. EAGLE: Mr. Chairman, I would like to invite Mayor Stokes to make a statement on behalf of the city of Cleveland. Mayor Carl Stokes.

MR. STOKES: Well, good morning, Mr. Stein and conferees, and members of the Lake Erie Enforcement Committee. It is my pleasure, as Mayor of the city here, to welcome you to Cleveland and to commend you on what I hope is going to be a progress report from all of those assembled. We want to feel that the word "progress" means that there is some kind of positive or forward motion going on, and it certainly is the desire of this administration to place and to keep pollution abatement on a positive basis. So I now welcome the opportunity afforded me to present what we feel is Cleveland's own progress report to you this morning, and I think it would be only appropriate for me to acknowledge, as I talk about this, that one of those who has done much during a period of five years to contribute to what, in some sense, is a progress report, is here this morning participating -- Ralph Locher, our former Mayor.

Well, ladies and gentlemen, since the total contribution of the State of Ohio to the flow in Lake Erie is only five per cent of the lake's total volume, it seems that the flow from Cleveland must be considered small compared with that of the entire lake. However, we here in this great city of ours are concerned with keeping this small portion of the flow into the lake as clean and free from pollutants as possible; and we do believe that our planned water pollution control program will accomplish this.

As far back as 1937, when only primary treatment was demanded by the then existing criteria for plants with effluents discharging into Lake Erie, the City of Cleveland designed, built, and placed in operation the Easterly Wastewater Treatment Plant. This plant provided secondary treatment for over 90 per cent removal of pollutants.

Now, some thirty years later, present design criteria call for secondary treatment for all plants whose effluents discharge into Lake Erie. Additional improvements on this plant will be under contract this month for approximately $4,500,000.

The Southerly Wastewater Treatment Plant is currently undergoing a $20,000,000 expansion program of which approximately $13,000,000 in improvements have already been completed. Now, these will substantially reduce the solids loading of the Cuyahoga River.

Westerly, the last of the three Cleveland wastewater treatment plants, will be under contract for construction by the middle of this summer signifying the start of a $25,000,000 new treatment plant.

The city of Cleveland has recognized the Cuyahoga River as the major source of pollution to Lake Erie in the Cleveland metropolitan area. It has now become somewhat of a fairly regular thing for us, as we talk about this problem, to say that we have the only river that tends to constitute a fire hazard. (Laughter)

But we are taking measures to abate this pollution that can honestly be attributed to our inadequate municipal facilities by the improvements previously enumerated. In addition, all of the sanitary sewage from the low lying areas along the Cuyahoga River is now being collected and pumped to treatment plants for full treatment.

In 1966, Cleveland created the Bureau of Industrial Wastes to deal specifically with the pollution of wastes other than those of a sanitary nature and has cooperated with the Cuyahoga River Basin Quality Committee, the State of Ohio Health Department, the Three Rivers Watershed Committee, and the Federal Water Pollution Control Administration in collecting and analysing samples throughout the metropolitan district.

In cooperation with its consulting engineers, the city of Cleveland has just completed a comprehensive study of the water pollution problem not only within the city but in our metropolitan area. This report is due shortly and will be available to interested parties. It will include data and information gathered over a two-year period.

I might now indicate to you that before completing my statement, I am going to tell you something that we think is -- well, we certainly know that in this area -- is unprecedented. We are going to have available to you here Mr. George Simpson of the Havens and Emerson Consultants, who, to the extent that you so desire, is going to try to detail to you what Cleveland is going to try to be doing in an unprecedented manner to tackle this problem of pollution control, at least to the extent that it is within our power to do, and within the realm of our responsibilities.

But, before that, let me say that the city of Cleveland is now installing two automatic water data monitors on the Cuyahoga River which will not only provide information on the river but will transmit, record and even signal to a remote location when and where parameters exceed predetermined levels.

Cleveland will consider additional installations of this type at critical locations on the Cuyahoga, in the harbor and in Lake Erie as its Master Plan calls for.

In my concluding remarks this morning and in the spirit of Cleveland: Now, we are going to ask for a mandate and a commitment from this community to clean up pollution in the Greater Cleveland area. This administration intends to present to Council a bond issue of up to $100,000,000 for the control and abatement of water pollution in the Greater Cleveland area. The issue will be presented to the voters in November if favorably passed by the Council within the next thirty days, and we have no reason to think that Council would not permit us to present this kind of issue for this kind of problem to the voters for their approval.

The comprehensive study of water pollution problems in the metropolitan area which will be released shortly indicates that $200,000,000 will have to be spent to clean up pollution in this area. This sum of money is programmed to be spent in the next four and one half years. Cleveland is taking the first and the major step to implement this program by asking the voters to pass this bond issue and these issues. The bonds themselves will, of course, be supported by the sewage revenues, and I might indicate here that the city of Cleveland does not only have the lowest sewage rates in the State of Ohio, but has among the lowest of all big cities in the entire United States.

Obviously all of us know, as the gentleman preceding us just indicated, that the big hangup in water pollution to this date has been money. Well, it is our feeling that with this bond issue and with matching funds by the Federal, we hope, the State, and the county government we will have sufficient funds to complete our water pollution program by late 1973 at the very latest.

Thank you, Mr. Stein. (Applause)

CHAIRMAN STEIN: Thank you, Mayor Stokes, for a very excellent statement and you have brought us encouraging news indeed.

I wonder if any of the conferees may have a comment or question?

MR. STOKES: Mr. Simpson will be here. Where is he? Will you stick around here in case any of the conferees wish to question something particular on what we plan to do? But we are going to do it!

CHAIRMAN STEIN: I know you will. Thank you very much, sir.

MR. EAGLE: If it is in order, I would like for Mr. Simpson, if he could, to briefly give the highlights of the comprehensive report.

CHAIRMAN STEIN: There would be no objection. I might point out that I think all of us in the business know that the key point is the financial point, and once you have gone ahead with your bond issue and that is arranged, we know -- we have worked for years with the people in Cleveland and in Ohio -- and there is no doubt in our mind as to your technical competence in doing the job, because the pollution control experts in this area are as sophisticated as any we have in the country. They know the problem as well as we do. So I think we are on our way.

MR. STOKES: I think we are on our way and we would like to invite everyone to help us campaign for this bond issue.

CHAIRMAN STEIN: We will be ready to do that.

MR. POOLE: Mr. Mayor, I am asking the same question I did of Detroit: Am I to assume that your entire program is hinged on, say, your $100 million in your bond issue plus Federal grants or do you expect to go ahead if there are no Federal grants with $100 million?

MR. STOKES: We are going to have to go ahead -- obviously much of this is going to depend to a great deal upon the Federal Government aiding and assisting us, and I want to repeat that the State is going to have to participate in this. It is not going to stop us -- at least whatever we can do on the local level by way of our financing we are going to be doing.

MR. OEMING: Mr. Stokes, I will make a deal with you: If we help you with your bond issue, will you come up and help Michigan with its bond issue?

MR. STOKES: Well, if mine passes, I will come. If it doesn't, I won't. (Laughter and applause)

CHAIRMAN STEIN: Mr. Eagle.

MR. EAGLE: This is Mr. George Simpson of Havens and Emerson, consulting engineers, of Cleveland.

CHAIRMAN STEIN: Mr. Eagle, I wonder if we could interrupt, and I am sorry. Congressman McCarthy has just arrived, and he has a commitment.

MR. EAGLE: We will yield to the Congressman.

CHAIRMAN STEIN: Thank you.

Congressman McCarthy has been an old friend of water pollution control and a watch dog of pollution control.

MR. POSTON: Murray, wouldn't it be better to say that he is a young friend of longstanding?

CHAIRMAN STEIN: Let's see how friendly he is going to be today.

Congressman McCarthy is on the Committee we go before in the Congress and is one of the most active congressional participants in pollution control affairs and one of the most knowledgeable men in the legislative branch of Government in our field. Congressman McCarthy is from Buffalo.

MR. McCARTHY: Well, thank you, Mr. Chairman.

Hon. Richard A. McCarthy

I want to preface my remarks today by expressing deep personal concern for the improvement of very aggravating water quality conditions in Lake Erie as a priority matter. Likewise, I hope it will be clearly understood that I have an equally strong interest in helping to achieve an equitable and wise exploitation of all natural resources in the entire Lake Erie region.

In our national efforts of water pollution abatement, the basic objective of Federal policy has been to upgrade the efficiency of existing waste treatment methods while simultaneously looking ahead to the prevention of any further degrading influences on water quality. This goal takes its form in three general ideas:

1. The idea of fully designing our treatment plants by incorporating the latest waste treatment technologies;

2. The idea of a total view of pollution influences: municipal wastes, industrial by-products, agricultural chemicals and runoff, oil spillage, and so on;

3. And, finally, the idea of using a combination of integrated resources planning, water quality criteria, research demonstration, government regulations, and financial incentives as the means of controlling our continuing pollution of the environment.

Nowhere is the need more urgent than here in the Lake Erie Basin for rigorously applying these fundamental ideas of pollution control.

This is particularly true in view of the potential polluting side-effects of the proposed oil and gas drilling in offshore areas on the United States side of the international boundary. In this connection, I think there are some striking parallels that can be drawn between the resource-oriented work of the Federal Power Commission and the Federal Water Pollution Control Administration.

You may recall that the National Power Survey of 1964, carried out by the Federal Power Commission, summarized the existing and expected trends of electric power generation in the entire Northeast Sector, and also outlined the considerations underlying the competition among fuel sources. According to the survey report, the Northeast Sector is quite fortunate in having close access to a broad range of good quality coal. The largest deposits lie in the Appalachian region of western Pennsylvania, southeastern Ohio, West Virginia and eastern Kentucky. The distance from coal mines to major load centers in this region -- with the exception of the New England States -- rarely exceeds 200 to 250 miles, and many of the important centers are within 100 miles.

In 1962, gas contributed only 4.1 percent of the total fossil-fueled power generation in this region while fuel oil accounted for 8.1 per cent. Fuel oil supplies, according to the report, are almost wholly from foreign sources and are used primarily in seaboard areas.

On the matter of interfuel competition, the report has this to say:

"The choice between competing fuels depends not only on delivered prices but on many other facts as well .... In determining the type of fuel to be used for electric generation, there are a number of factors to be reviewed and evaluated. Each of these has a bearing on cost and influences the degree to which an electric utility is able to meet its obligation to provide reliable service at a reasonable price. In locations where land costs are high and areas heavily congested, these costs become a major consideration in selecting a proper fuel. In some areas, operating conditions, such as air control regulations on the west coast, may justify a premium fuel. Therefore, while a general picture can be drawn concerning the availability and price of fuels, the final determination in selecting a fuel or fuels ... must be based on the specific facts ...."

As an illustrating case in point consider the recent case of Scenic Hudson Preservation Conference v. Federal Power Commission (354 F. 2d 608-2d Cir. 1966).

The Commission had licensed Consolidated Edison of New York to construct a pumped storage generating project in New York. On appeal from a citizen group concerned with the aesthetic impact of that decision, the Commission was reversed and ordered to consider certain alternatives posed by the citizens. The Court said:

"If the Commission is properly to discharge its duty in this regard, the record on which it bases its determination must be complete. The petitioners and the public at large have a right to demand this completeness. It is our view, and we find, that the Commission has failed to compile a record which is sufficient to support its decision. The Commission has ignored certain relevant factors and failed to make a thorough study of possible alternatives to the Storm King project. While the Courts have no authority to concern themselves with the policies of the Commission, it is their duty to see to it that the Commission's decisions receive that careful consideration which the statute contemplates ...."

More recently, the Supreme Court sent another case back to the Federal Power Commission together with this guidance:

"The test is whether the project will be in the public interest. And that determination can be made only after an exploration of all issues relevant to the 'public interest,' including future power demand and supply, alternate sources of power, the public interest in preserving reaches of wild rivers and wilderness areas, the preservation of anadromous fish for commercial and recreational purposes, and the protection of wildlife."

The overtones of these decisions are clear. The Courts have recognized that a wide range of factors should be considered in determining and selecting the most appropriate development scheme for important natural resources, particularly in highly congested areas.

Now I believe there is no question but that the factor of pollution in Lake Erie should be in the forefront of any discussions concerning offshore exploration for new fuel sources. Apart from the economic, aesthetic and conservation impacts one fuel choice bears on another, there is the much more urgent question of whether improperly controlled oil and gas drilling will aggravate what is already one of the most serious pollution situations in the entire country. I recognize, of course, that natural gas as a fuel leaves fewer objectionable pollutants than coal or oil. But we have also been told by the Federal Power Commission and other experts in this field that desulfurization may soon restore the superiority of coal.

As you know, Mr. Chairman, the whole question of oil pollution control is now being considered by the

Congress in the subcommittee on which I serve. Future enactment of legislation will have a direct bearing on the proposed oil and gas exploration in Lake Erie. Also the International Joint Commission is looking ahead into the international aspects of the oil and gas exploration problem including such matters as compensation for damages, uniformity of regulations, and production pooling. Both New York and Ohio have vital economic interests in Lake Erie's submerged resources, but these States have postponed plans to lease bottomlands pending further investigations. Michigan has stated that it will not lease lands in Lake Erie for mineral development. Moreover, Michigan and the Province of Ontario have agreed not to permit any exploratory activities in Lake Huron, Lake St. Clair, and the St. Clair and Detroit Rivers, which brings me to the main point of my being here, and which I regard of sufficient importance to have induced me to arise at 5:30 this morning to come out here from Washington, where I must return this afternoon to be on the Floor of the House, at my own expense.

In light of these events, I think it is most unfortunate -- indeed it borders on the scandalous -- that the State of Pennsylvania is moving ahead with the awarding of drilling contracts. Accidental spillage of oil on a body of water such as Lake Erie can do great damage. Experience in other offshore drilling areas has shown that spills do occur even under the best of circumstances. For example, Interior Secretary Udall recently found it necessary to call upon the Western Oil and Gas Association to enter into an emergency effort to cope with an increasing number of water pollution incidents caused by oil exploration in Alaska's Cook Inlet. I feel certain that drilling operations would also tend to increase navigation hazards and be inimical to yachtsmen, swimmers, water skiers and fishermen on highly used Lake Erie.

If the Federal Water Pollution Control Administration is properly to discharge its function on the basis of existing legislative authority, then I believe it must make every effort at its disposal to intervene in the proposed exploration of submerged lands. What the citizens of this entire basin will expect is not after-the-fact prosecution of violators of existing water quality standards. Rather the public must be assured that the joint Federal-State water standards are backed up with appropriate mechanisms to prevent any oil and gas pollution that might result from exploratory and development programs. The anti-pollution stipulations Pennsylvania decides to include in its leasing arrangements simply may not be adequate in terms of the other States' views. And existing water quality standards agreed to by the States should probably be jointly revised in order to meet this need as well as to anticipate the Congressional intent with respect to pending oil pollution legislation.

I can assure you that our committee is watching this situation very closely. As I stated earlier, Mr. Chairman, rapid and economical treatment of the wide variety of waste products entering Lake Erie is a priority matter, and I think that this whole pollution effort is now hanging in the balance. If Pennsylvania goes ahead with this, I think the public is going to be thoroughly disenchanted, and the integrity and the sincerity of this conference that has been in existence now for several years will be seriously compromised. The public just won't believe that this is a serious effort, if we are going to spend billions of dollars to clean up Lake Erie, and at the same time permit the start on a new source of pollution. The public just is going to say, "Well, it is a farce."

The rapid economical treatment of the wide variety of waste products entering Lake Erie is indeed a priority matter, vital to the health and future well-being of this entire region. At the same time, wider economic interests must not be overlooked. Only in this way will this region's total resources endowment be put to its best use.

Thank you, Mr. Chairman, and members of the panel.

CHAIRMAN STEIN: Thank you, Congressman McCarthy.

Does anyone want to make comments or observations?

Mr. Lyon.

MR. LYON: Congressman, I know this isn't the place nor the time to get --

MR. McCARTHY: I think it is.

MR. LYON: Fine. -- to get in a public debate on this, but I want to tell you, first of all, that we in Pennsylvania are just as concerned with pollution of Lake Erie as you are. We are just as satisfied that the leases that have been issued by the Commonwealth of Pennsylvania are the strictest leases that have ever been issued in the 150 years of drilling on Lake Erie.

From what you said it would make it appear that there hasn't been any drilling on this lake. I think you know that the whole Ontario side of the lake has been leased for drilling and that there is no evidence that this has caused in the recent past any pollution whatsoever.

The leases which Pennsylvania has issued are the strictest leases that Pennsylvania has ever issued, and, by the way, we have issued leases and permits for drilling on the lake before. The drilling was done very satisfactorily. There was no pollution whatsoever from this drilling, and I have copies of the key provisions of these leases here for you to see. They are more strict than the leases issued by the Secretary of Interior for off-shore drilling. We are very much concerned about pollution from drilling operations, but we are convinced that this can be done.

We have only issued leases for a very small area of Pennsylvania -- the Pennsylvania part of the lake -- while Ontario, as I said before, has successfully drilled for several generations without causing any pollution.

I would be happy to give you a copy of the provisions of our leases which are here, and with the permission of the Chairman would like to make them a part of our record.

(The above-mentioned documents follow.)

MR. McCARTHY: I don't doubt the accuracy of your statement as regards to Pennsylvania, and I don't preclude eventually getting into this. But in light of what New York and Ohio and Michigan have done, and in view of the fact that today legislation on this subject is being considered in the Congress, and in light of the Court decisions that I have cited, I think it is arrogant of Pennsylvania to go ahead with this.

M-O&G-LE-68
Oil & Natural Gas Lease

Commonwealth of Pennsylvania
Department of Forests and Waters
Division of Minerals
P. O. Box 1467
Harrisburg, Pennsylvania 17120

Contract No. ____________

OIL AND NATURAL GAS LEASE FOR THE LANDS BENEATH LAKE ERIE WITHIN THE JURISDICTION OF THE COMMONWEALTH OF PENNSYLVANIA

THIS AGREEMENT made and entered into on this day of , 19 , by and between the COMMONWEALTH OF PENNSYLVANIA, acting through the DEPARTMENT OF FORESTS AND WATERS, hereinafter designated "Lessor," and ____, a ____________________ Corporation, hereinafter designated "Lessee," with its principal place of business at ____ and authorized to do business in the Commonwealth of Pennsylvania.

WITNESSETH: THAT,

WHEREAS, Lessor is authorized by Act 293, dated July 5, 1957, amending the Administrative Code of 1929, (P. L. 177), Article XVIII, Section 1802, paragraph (g), to make and execute contracts or leases in the name of the Commonwealth for the removal of oil and natural gas beneath those waters of Lake Erie owned by the Commonwealth whenever it shall appear to the satisfaction of Lessor that it would be for the best interests of the Commonwealth to make such removal; and

WHEREAS, Lessor made a determination that the leasing of oil and natural gas rights in the premises hereinafter described will be for the best interests of the Commonwealth and authorized leasing of the same; and

WHEREAS, the proposed leasing of said lands was duly advertised as required by law. Upon the opening of the bids, submitted pursuant to such advertising, Lessee herein was found to be the highest responsible bidder.

NOW THEREFORE, in consideration of the sum of Dollars ($), paid to Lessor by Lessee (the receipt whereof is hereby acknowledged by Lessor) and other mutual covenants and agreements hereinafter set forth, Lessor does hereby grant, demise, lease, and let exclusively unto Lessee for the purpose of exploring for, drilling for, operating for, producing, removing, and disposing of oil, natural gas, and liquid hydrocarbons; at locations subject to the approval of Lessor, the drilling of wells, the laying of pipelines, including any and all necessary appurtenances, attachments and cathodic protection devices and the building and installation of approved tanks, towers, stations, and structures thereon to produce, save, take care of, and transport said products, in lands beneath all that/those certain block/blocks of Lake Erie comprising acres, more particularly described on the Oil and Natural Gas Lease Attachment, identified as Exhibit "A" and as shown on the Map, identified as Exhibit "B" which are attached hereto and made a part hereof, hereinafter referred to as the "leased premises." It is understood that the aforesaid acreage and the location shown on the Map, identified as Exhibit "B" are approximate. For the purpose of calculating any payments based on acreage, the acreage aforementioned will be used.

1. INTERPRETATION AND LIMITATION OF LEASE

1.1 The rights granted in this lease apply only to oil, natural gas and liquid hydrocarbons.

1.2 In this lease, oil, natural gas, and liquid hydrocarbons shall not mean and include helium or any sulphur produced in association with the foregoing.

1.3 Rights to all minerals and substances other than oil, natural gas and liquid hydrocarbons on or beneath the bed of Lake Erie are reserved to the Commonwealth of Pennsylvania.

1.4 The right to use any part of the leased premises for gas or LPG (fluids) storage is expressly reserved to the Commonwealth of Pennsylvania.

2. TERM OR PERIOD

2.1 It is agreed that this lease shall remain in force for a term of ten (10) years from the date first written above, subject to all terms and conditions hereinafter set forth and shall continue from year to year thereafter so long as oil or gas is produced in paying quantities from said land or as long as Lessee is engaged in bona fide attempts to secure or restore the production of oil, natural gas and liquid hydrocarbons by conducting drilling, or reworking operations on the leased premises or engaged in the abandonment, or removal of equipment therefrom.

2.2 In the event that Lessee is engaged in drilling operations or is prevented by weather or water conditions from carrying on drilling operations in progress at the expiration of the ten (10) year term, Lessor may upon application in writing within thirty (30) days following the ten (10) year term extend the lease for a period not to exceed six (6) months.

2.3 The months from November to March, both inclusive, shall not be computed in the extended period.

3. RENTAL

3.1 The first annual rental will be the amount of the bonus bid for the above described premises and is payable upon execution of this lease by Lessee.

3.2 After the first year, Lessee agrees to pay Lessor an annual rental in advance for the above described premises at the rate of ONE DOLLAR ($1.00) per year for each acre of this lease retained by Lessee. The rental shall be paid on or before the anniversary date of this lease. Each successive rental thereafter shall be paid on or before the anniversary date of this lease.

3.3 The completion of each well on the leased premises to or through the Ordovician Queenston Formation, or shallower depths if approved as stipulated, shall reduce the rental set out in the preceding paragraph by the amount of rental on the number of acres attributable to each well as provided in the section entitled, "SUBSEQUENT WELLS," which reduction shall become effective on the next rental date after such well has been completed and shall apply whether the well is a producer or a dry hole. If such wells are drilled on a unit created by a spacing order of the Pennsylvania Oil and Gas Conservation Commission, or on a unit created by a voluntary unitization agreement entered into with the approval of Lessor, a well drilled on such unit shall reduce the rental prescribed above by the amount of rental attributable to the acreage contained in the portion of the leased premises included in such unit.

4. OIL ROYALTY

4.1 Lessee shall pay to Lessor, as royalty, one-eighth (1/8 of the field price per barrel (42 U.S. Gallons) at 60° F. produced and saved from the leased premises for all oil, condensate and other liquid hydrocarbons of like grade and gravity which prevails in that area on the day such oil and other products are run into the pipeline or into storage tanks.

4.2 Lessor may at his option, however, demand that Lessee deliver to the credit of Lessor, as royalty, free of cost, in the pipeline to which Lessee may connect its wells, the equal one-eighth (1/8) part of all oil, condensate, and other liquid hydrocarbons produced and saved from the leased premises.

4.3 If gas, oil, condensate, and other liquid hydrocarbons, each in paying quantities, should be developed from the same well, then the gas and the oil, condensate and other liquid hydrocarbons shall be saved.

4.4 Lessee shall gauge, measure, sample, and test all petroleum and petroleum products in accordance with standard practices as outlined in American Petroleum Institute Standard 2500, January 1, 1955, or as subsequently amended by the same authority, and at a temperature base of 60° F. Lessee shall provide tanks for accurately measuring the crude oil produced from the lease. Positive copies of 100 percent capacity tank tables are to be furnished to Lessor or other acceptable standards of measuring production.

5. GAS ROYALTY

5.1 To pay Lessor, as royalty, Four Cents ($0.04) per thousand cubic feet (Mcf) or one-eighth (1/8) of the market value, thereof, at the mouth of well, whichever is higher for all gas and other gaseous substances produced and saved from each gas well drilled on the leased premises.

6. SHUT-IN WELLS

6.1 If at any time or times there is on the leased premises a well or wells capable of producing oil or gas or both and the well or wells are shut-in, suspended, or otherwise not produced and the gas is not used or marketed therefrom during any year ending on an anniversary date of this lease, Lessee shall pay Lessor at the expiration of each said year for that year a sum equal to Two Dollars ($2.00) per acre for the number of acres then covered by this lease for each such well and each such well shall be deemed to be a producing well hereunder. The failure to make such payment shall subject the lease to forfeiture.

7. GAS MEASUREMENT

7.1 All gas producing wells shall be equipped with adequate facilities for continuously metering gas suitably safeguarded from weather and from interference by unauthorized persons, and no gas shall be produced at a well unless it is metered, except that Lessor may give permission to dispense with the installation of a meter or facilities for metering and permit group meter measurements instead. The meter charts and relevant records shall be kept in a permanent file and be made available to Lessor on request.

7.2 Where, in the opinion of Lessor, adequate measurements are not being made of the gas produced from a well or wells, Lessor may require that the well or wells be closed in until such time as provisions for adequate measurements have been made.

7.3 The volume of gas produced, saved, and marketed shall be measured according to Boyle's Law for the measurement of gas under varying pressures with deviations therefrom, as provided in paragraph e. below, on the measurement basis hereinafter specified and shall be determined as follows:

a. The unit of volume for the purpose of measurement shall be one (1) cubic foot of gas at a temperature of sixty degrees (60°) Fahrenheit and an absolute pressure of 14.73 pounds per square inch.

b. The average absolute atmospheric pressure shall be assumed to be 14.4 pounds to the square inch, irrespective of actual elevation or location of Point of Delivery above sea level or variations in such atmospheric pressure from time to time.

c. The temperature of the gas passing the meters shall be determined: (1) By the continuous use of a recording thermometer so installed that it may properly record the temperature of the gas flowing through the meters. The arithmetic average of the temperature recorded each 24-hour day shall be used in computing gas volumes; (2) If a recording thermometer is not installed, or if installed and not operating properly, an average flowing temperature of fifty degrees (50°) Farhenheit shall be used in computing gas volume.

d. The specific gravity of the gas shall be determined by tests made by the use of an Edwards or Acme gravity balance, at intervals of three (3) months, or at such intervals as are found necessary in practice. Specific gravity so determined shall be used in computing gas volumes.

e. The deviation of the natural gas from Boyle's Law shall be determined by tests at intervals of three (3) months or at such other shorter intervals as are found necessary in practice. The apparatus and the method to be used in making said test shall be in accordance with the recommendations of the National Bureau of Standards of the Department of Commerce, or Report No. 3 of the Gas Measurement Committee of the American Gas Association or any amendments thereof, or any other mutually agreed upon method. The results of such tests shall be used in computing the volume of gas delivered hereunder.

7.4 No gas from any gas well, except such as is produced in a cleanup period not to exceed 48 hours after any completion or stimulation operation, plus that used for the controlled testing of the well's potential in a period not to exceed 24 hours, plus that used in any operational requirements, shall be permitted to escape into the air. Extensions of these time periods shall be granted by Lessor upon application if the Lessee demonstrates sufficient good cause.

7.5 All gas wells capable of production shall be equipped with wellhead controls adequate to properly contain and control the flow thereof.

7.6 Lessor may require the periodic testing of any gas well in such a manner as Lessor may prescribe in order to establish the producing capacity and characteristics of the well.

8. STATEMENT

8.1 Lessee shall submit statements to the office of Lessor at Harrisburg, Pennsylvania, by individual wells of the production and sales of oil, gas, other hydrocarbon products, and other products not later than the twenty-fifth (25th) day of each calendar month covering production and sales for the preceding calendar month.

9. PAYMENTS

9.1 Lessee shall be held responsible for the payment of all royalties, which shall be mailed to the office of Lessor at Harrisburg, Pennsylvania and made payable to Lessor. Payments of royalties shall be made not later than the twenty-fifth (25th) day of each calendar month covering production or sales during the preceding calendar month.

10. PROTECTION AND CONSERVATION

10.1 Lessee agrees to conduct all operations in such a manner as to comply with the provisions set forth in the STIPULATIONS FOR THE PROTECTION AND CONSERVATION OF THE SUBMERGED LANDS AND THE WATERS OF LAKE ERIE, identified as Exhibit "C" attached hereto and made a part hereof.

11. OPERATIONS

11.1 Lessee agrees that it will carry on operations under this agreement with all due diligence and in a competent and workmanlike manner, in accordance with the best offshore oil and gas field practices.

12. FIRST WELL

12.1 Lessee shall drill a well on each block leased or on unitized acreage containing a portion of a lease block, but the well need not necessarily be on the portion of the lease block contained within the unit. Lessee agrees to commence and proceed with operations for the drilling of a well to the Ordovician Queenston Formation, at a location approved by Lessor, within five (5) years from the date first written above, and shall continue operations in a workmanlike manner to complete said well, and all wells herein stipulated, with due diligence. If, however, gas or oil or both are found in marketable quantities in a shallower formation, that well may satisfy the first well requirements of this paragraph upon the written approval of Lessor. In the event, the aforesaid well is not commenced within the above mentioned five (5) year period, the lease shall be terminated in its entirety.

13. WELL SPACING

13.1 All wells drilled in Lake Erie in the absence of a spacing order of the Pennsylvania Oil and Gas Conservation Commission shall be subject to a spacing density of one gas well per tract (approximately 630 acres - 1 Minute of Latitude by 1 Minute of Longitude). Oil well spacing will be no more than one well per approximately 40 acres, or 16 wells per tract. Exceptions to these spacings may be allowed by Lessor upon proper justification by Lessee. Such exceptions must be authorized in writing.

13.2 The first well in each tract (1 Minute of Latitude by 1 Minute of Longitude) is to be located in the center of the northwest quarter of the northwest quarter (NW NW) of the tract for flexibility in well spacing programs, subject to approval of Lessor. Exceptions to this location may be allowed if Lessee shall submit to Lessor the information upon which such exception is based. Such exceptions must be authorized in writing.

13.3 The spacing of wells shall also be subject to all regulations and restrictions imposed by the United States Coast Guard and the United States Army Corps of Engineers in regard to shipping lanes, docks, and other areas under their jurisdiction.

14. SUBSEQUENT WELLS

14.1 If the well or wells required under Paragraph 12.1 hereof or any subsequent well produces oil or gas or both in marketable quantities, then Lessee shall drill an additional well or wells through the producing formation during the same lease year. Lessee will commence and proceed with the drilling of at least one (1) well to or through the producing formation on each lease block, each and every lease year thereafter so long as successive wells have marketable production. Wells may be drilled on a unit containing a portion of a lease block, but not necessarily on the lease block portion of the unit. If Lessee concludes that an additional well or wells is not justified, then Lessee shall submit to Lessor the information upon which the conclusion is based. If Lessor determines upon review of such information that an additional well should be drilled, then Lessee shall have the option of drilling an additional well within six (6) months from Lessor's written determination or releasing all of the acreage covered by the lease except for forty (40) acres around each well from which oil is produced as the principal product and six hundred and thirty (630) acres around each well from which gas is being produced as the principal product.

14.2 Lessee shall not be required under this provision to drill more wells than required or allowed under any spacing order, rule, or regulation of the Pennsylvania Oil and Gas Conservation Commission, or in the absence of any such order, more than one well for each forty (40) acres where oil is being produced as the principal product of such well, or more than six hundred and thirty (630) acres where gas is being produced as the principal product of such well.

14.3 The amount of acreage included in a spacing unit by the Pennsylvania Oil and Gas Conservation Commission or in the absence of an order by such Commission, forty (40) acres where oil is being produced as the principal product of such well, or six hundred and thirty (630) acres where gas is being produced as the principal product of such well, shall be referred to elsewhere in the lease as acreage attributable to each well.

15. RESTRICTED AND RESERVED AREAS

15.1 The areas in Lake Erie within one-half mile of the International Boundary, the Ohio Boundary, and the New York Boundary are restricted drilling areas. No wells may be drilled in these areas without written permission of Lessor. These areas may be drained without a competitive offset program unless geological conditions warrant closer spacing. Where feasible, these areas will be unitized for proper spacing and management.

15.2 An area in Lake Erie along the shoreline and in the vicinity of the Presque Isle Peninsula is reserved. This area is shown on the Map, identified as Exhibit "B" which is attached hereto and made a part hereof.

16. DEVELOPMENT

16.1 Lessee agrees to conduct the drilling of all wells as a reasonable and prudent operator would drill under the same or similar circumstances. After discovery of oil or gas on the leased premises, Lessee shall develop and produce all wells from the described leased premises in an efficient and economic manner, without waste, and to the best advantage of Lessor. Lessee will plan and develop all wells in accordance with the rules and regulations of the Oil and Gas Division, Pennsylvania Department of Mines and Mineral Industries.

16.2 It is understood and agreed that Lessee is privileged to develop oil or gas from formations shallower or deeper than the Ordovician Queenston Formation provided that commitments and provisions of this lease are at all times fulfilled. The operator shall apply the same degree of precaution and control as outlined for the Ordovician Queenston Formation operations to drilling, casing, and completing operations of the other formations, both below and above the Queenston Formation.

17. OFFSETS

17.1 Lessee agrees to promptly offset within ninety (90) days any wells located on other blocks owned by the Commonwealth leased to other parties than Lessee at a lesser royalty or owned by the States of Ohio or New York or the Canadian Province of Ontario, which are within 2,260 feet of any boundary described in this lease and are producing gas or oil in marketable quantities; or any well that is completed within the radius of the drainage area set by an order of the Pennsylvania Oil and Gas Conservation Commission. This provision may be waived by Lessor in writing upon Lessee's application, when evidence shows that such offsetting well is unnecessary or economically unsound. However, if Lessor determines in writing that an offsetting well should be drilled, Lessee will have the option of drilling the well as required or paying to the Commonwealth compensatory royalty on production from the offset well. This payment shall be based on the ratio the affected acreage bears to the total acreage drained by the well. Lessee may at its option release all of the acreage of the leased premises except forty (40) acres around each well from which oil is being produced as the principal product and six hundred and thirty (630) acres around each well from which gas is being produced as the principal product. Lessee may also release that drainage acreage attributable to a well by an order of the Pennsylvania Oil and Gas Conservation Commission if the affected acreage falls within an area subject to such a spacing order.

17.2 In the event that Lessee is prevented by weather or by ice conditions in the lake from drilling a required offset well during the ninety (90) day time period, Lessee may apply to Lessor for an extension of the time limit not to exceed six (6) months. The months from November to March, both inclusive, shall not be computed in the extended period.

17.3 No well on the leased premises shall be shut-in if drainage will occur through offsetting wells within the aforeprescribed distances for oil and gas wells. If such offsetting gas wells are on compression, the offset wells on the leased premises shall be placed on compression.

17.4 Lessee agrees that any well along the boundary line, contingent to other lands where oil and gas are owned by the Commonwealth, shall be located at least 660 feet from such boundary; or that distance from such boundary line which will be the radius of the drainage area set forth by an order of the Pennsylvania Oil and Gas Conservation Commission, if the area is subject to such a spacing order. Upon application by Lessee, this provision may be waived in writing by Lessor when deemed in the best interest of the Commonwealth and not in an area subject to a spacing order of the Pennsylvania Oil and Gas Conservation Commission.

18. UNITIZATION

18.1 Lessee shall have the right at any time, where this lease is offset by blocks on which oil and gas rights are leased to other parties, to unitize this lease in whole or in part to secure the most efficient and economical development and production of the oil and gas resources of the reservoir or reservoirs and in the best interests of sound management and production practices. Lessee may participate in such joint operating and development agreements to prevent drilling of an excessive number of wells, or of wells located too close to the boundary of the leased premises. Such joint operating agreements and termination thereof shall be approved in writing by Lessor. If such joint operating agreements or unit agreements are entered into pursuant to a valid Spacing or Integration Order of the Pennsylvania Oil and gas Conservation Commission, the approval of Lessor shall not be required.

18.2 Drilling, or reworking operations upon, or production of oil and gas from, any part of any such unit shall be treated for all purposes hereunder as operations upon or production from the leased premises.

18.3 Upon production from any part of any such unit, Lessor shall be entitled to and Lessee shall pay royalties calculated as follows: there shall be allocated to the portion of this lease included in such unit a fractional part of such production on the basis the ratio of the acres from the leased premises included in such unit bears to the total number of acres included in the unitized area and Lessor shall be entitled to the royalties provided for in this lease on such fractional part of such production and no more; provided, that if Commonwealth authorities shall prescribe a different method of allocation, the method so prescribed shall prevail.

19 PIPELINES

19.1 Lessee is herewith granted the right to lay any necessary pipelines at or below the level of the lake bottom on or under the leased premises for the sole purpose of removing oil, gas or other materials from the block or blocks under lease. Any pipelines under shipping lanes and anchorages must be buried. A route map for each line shall be submitted to the Lessor, the United States Coast Guard, and the United States Army Corps of Engineers for their approval in writing as to location ninety (90) days prior to the laying of that pipeline.

19.2 Where the Lessee's pipelines cross offshore blocks not already leased to it, Lessee must enter into a pipeline right of way agreement with Lessor. Lessor reserves the right to grant pipeline rights of way across the block or blocks leased to other lessees of the Commonwealth providing the opeations of Lessee are not unduly hampered thereby.

19.3 All pipelines shall be laid on or below the lake bottom. Before a pipeline may be used to transport any fluids not indigenous to the waters of the lake, it shall be tested with fresh water to a pressure of twice the anticipated working pressure. No gas or fluids may be transported in pipelines until approval is given by Lessor.

20. LESSEE'S USE

20.1 Lessee shall have the privilege of using sufficient gas from the leased premises, free of royalty, to run all machinery necessary for drilling thereon.

21. DRILLING

21.1 Prior to beginning any drilling operations, Lessee shall submit to Lessor, the United States Coast Guard and the United States Army Corps of Engineers, for their approval, a plan of the drilling program to be carried out. This plan shall include:

(a) a location plat of the proposed well, Scale 1 inch = 400 feet, which shows and contains: (1) the proposed drilling unit and its position in the lease block; (2) its distance from the boundary of the proposed drilling unit; and (3) unitization with adjacent tracts. The well location must be surveyed to the nearest one-half second (1/2") of longitude and latitude. The well location shall be verified and amended as required by precise survey with the drilling rig on location and the elevation above sea level provided. If the well is to be directionally drilled, the projected bottom hole location of the well is to be shown;

(b) designation of the well by number and lease block;

(c) the geological formation to be tested or used and the proposed total depth;

(d) the type of drilling tools or equipment to be used;

(e) the plan for disposal of water, drilling fluid, and other waste substances resulting from obtained or produced in connection with exploration, drilling, or production of oil and gas;

(f) a detailed plan for casing and cementing of the proposed well;

(g) a detailed plan for plugging and abandoning the proposed well if the well should prove nonproductive.

21.2 No well shall be commenced, deepened, reopened, or plugged back without authorization of Lessor in writing and before a permit has been issued by the Oil and Gas Division of the Pennsylvania Department of Mines and Mineral Industries. Lessor shall be notified at or immediately prior to the start of drilling operations.

21.3 The location of a well shall not be changed without prior written approval of Lessor.

21.4 With the first show of gas or oil, drilling operations must be suspended and the casing tested and found to be free from all leaks before drilling is continued.

21.5 At the end of every drilling or plugging operation, Lessee shall ensure that any platform, piling, anchor post or other obstructions are removed as soon as is reasonably possible, and in any case within thirty (30) days. A permanent platform of approved design may be installed for the production of oil or gas.

22. IDENTIFICATION

22.1 Lessee shall display a prominent sign at all structures placed in the lake for drilling, producing, or reconditioning a well, or for handling or processing produced fluids. This sign shall be located in a conspicuous place and shall include the name of Lessee, the name and number of the well or facility, and a description of the well or facility location by latitude and longitude. The sign shall not be removed or changed without written approval of Lessor. In case of lake bottom completions or subbottom completions, identification satisfactory to Lessor shall be placed at the wellhead.

23. DEVIATION AND DIRECTIONAL WELL SURVEYS

23.1 Lessee shall drill a straight hole to the best of his ability. The maximum point at which a well penetrates a producing formation shall not vary unreasonably from the vertical drawn from the center of the hole at the surface. Minor deviations will be permitted, for short distances, to straighten the hole, to sidetrack junk or to correct other mechanical difficulties.

23.2 Lessee shall run a device for measuring deviation from the vertical every five hundred (500) feet and at the total depth and shall provide Lessor with this information. If Lessor determines from this information that a well has been deviated excessively, he shall have the right to require Lessee to have a complete angular deviation and directional survey made in the well by an approved well surveying company and certified as to correctness at Lessee's sole risk and expense. In the event the survey reveals any unreasonable violations of the applicable well location or spacing regulations, Lessor may either require the excessively deviated well to be redrilled or to be plugged and abandoned by Lessee.

23.3 If Lessee fails to take a deviation survey, Lessor may order that, until the survey is made, no further drilling be done; or if the well has been placed on production, no further production be taken.

23.4 Lessee may conduct directional drilling operations upon the approval of Lessor in writing so long as, at depth, there is no encroachment upon adjoining leaseholds or drilling units. Lessee shall make written application to Lessor and provide the following information:

(a) names of field or area, pool, block, tract and well number;

(b) description of the well location and of the target bottomhole location in feet from the two nearest lease boundaries;

(c) reason for the proposed intentional deviation;

(d) names and addresses of the offsetting lessees and a statement that each has been sent a copy of the application and a map by registered mail, and the date of such mailing. The map must be drawn to a suitable scale which shows the well; all offsetting leases and the wells located thereon; the pool in which they are completed; and the names of the offsetting lessees.

23.5 Within thirty (30) days after the completion of an intentionally deviated well, a complete angular deviation and directional survey of the well obtained by an approved well surveying company and certified as to correctness shall be furnished to Lessor.

24. BLOWOUT PREVENTERS AND CASING HEADS

24.1 Lessee shall maintain at all times the casing control equipment in such condition that will effectively control any oil, gas, or water encountered during operations in a well being drilled, tested, completed, or reconditioned. All drilling wells or wells being serviced by a rig, shall be equipped with working blowout control equipment tested to twice normal hydrostatic pressure for the depth drilled that will completely close off the open hole and will completely close off around any equipment being employed in the well, and will be equipped with a bleed-off valve of the proper size and working pressure. If, the blowout preventer is hydraulically operated, adequate pressure shall at all times be available for efficient operations. Blowout control equipment must be capable in case of an emergency of shutting in the well at a point at least fifty (50) feet from the wellhead.

24.2 When rotary drilling equipment is used during drilling, all wells shall be fitted with a suitable valve in proper working order for the purpose of shutting off the hose connections should the hose blow out.

24.3 All wells shall be equipped with casing heads of rated working pressure of twice normal hydrostatic pressure for the depth drilled, with adequate connections and valves available to permit pumping mud-laden fluid between any two strings of casing at the surface. Reconditioning shall be required on any well showing pressure on the casing head or leaking gas or oil between the oil string and next larger size casing string, when in the opinion of Lessor such pressures or leakages assume hazardous proportions or indicate the existence of underground waste. Mud-laden fluids may be pumped between any two strings of casing at the top of the hole, but no cement shall be used except by special permission of Lessor. No casing shall be perforated until adequate control equipment has been installed and in good working order. Such control equipment shall consist of Master Valve and Lubricator, or their equivalent. The entire equipment shall be in good working order and condition at all times.

24.4 While a well is being drilled, Lessee shall test control equipment daily and record the results of such tests daily.

24.5 Whenever an inspection shows that the casing or control equipment at a well is not adequate, Lessor may prescribe remedial measures which shall be complied with before any further drilling.

25. DRILLING MUDS

25.1 When drilling with rotary tools, drilling mud of sufficient weight, capable of controlling formation pressures and preventing oil and gas blowouts or flows of water, shall be maintained on the location of a drilling well at all times.

26. CASING PROGRAMS

26.1 All casing, tubing, and equipment used in the drilling of a well shall be in good condition and adequate for the depths to be drilled and the pressures that may be encountered.

26.2 Lessee shall comply with the oil and gas statutes, rules and regulations of the Commonwealth with regard to preventing the escape of oil, gas, or water out of one stratum into another, preventing the pollution of any fresh water supply and preventing blowouts.

26.3 When drilling with cable tools, a conductor string of new or reconditioned casing shall be driven into the lake bed. All wells must be equipped with a string of surface casing which shall be set and cemented at a sufficient depth below the top of a competent rock formation so that all fresh water reservoirs will be confined. Lessor shall set depth requirements for each well based on the depth of fresh water reservoirs in the area. This surface casing shall be new or reconditioned of sufficient test to withstand pressures for the depth at which it is run. Sufficient cement shall be used to fill the calculated annular space back of the surface casing to the lake bed plus 15%. Cement shall be allowed to stand a minimum of 12 hours under pressure and a total of 24 hours before drilling plug or beginning tests. The term "under pressure" as used herein shall be considered as being complied with, when one or more back pressure valves are found to be holding. Casing shall be tested by pump pressure to at least 1,000 pounds per square inch. If, at the end of 30 minutes the pressure shows a drop of 50 pounds per square inch or more, the casing shall be considered unsatisfactory for its purpose. After the corrective operation, the casing shall be again tested in the same manner before drilling continues.

26.4 When cable tool drilling is used, intermediate strings of casing shall be set inside the surface casing if it is necessary to confine any gas, oil, or water originating from intermediate horizons prior to the setting and cementing of the production string of casing. Intermediate casing may be cemented through any potential producing horizon with cementing procedures approved by Lessor.

26.5 The producing or oil string shall be new or reconditioned seamless pipe of not less than 4-1/2 inch outside diameter with a mill test of at least twice normal hydrostatic pressure for the depth drilled. After cementing, the casing shall be tested by pump pressure to at least twice normal hydrostatic pressure for the depth drilled. If at the end of 30 minutes, pressure shows a drop of 50 pounds per square inch or more, the casing shall be repaired sufficient to withstand the pressure test described herein. After the corrective operation, the casing shall again be tested in the same manner. Cementing shall be made by pump and plug method. Sufficient cement shall be used above the shoe to fill the calculated annular space back of the casing to the lake bed plus 15%. Cement shall be allowed to stand a minimum of 24 hours before drilling plug or initiating tests. In the event the producing string is set through all known producing formations, a minimum of 20 feet of cement shall remain in the bottom of the casing.

26.6 The waiting period on cement may be reduced from 24 hours upon approval of Lessor.

27. COMPLETION OF WELLS

27.1 All reasonable preparations and precautions shall be made before a well is drilled in for the preventing of waste and the contamination of the lake by oil, gas or well fluids. Reasonable provision shall be made for producing and storage equipment before a well is placed on production.

27.2 Lessee shall insure that the production casing is cemented to surface before production commences.

27.3 Lessee shall complete and connect all producing wells to pipelines as near as practical to the level of the lake bottom. The wellhead is to be encased in a cellar below lake bottom. The maximum height of the wellhead assembly above the lake bed may be 2-1/2 feet upon written approval of Lessor. All wells shall be cleaned, tested, and produced in a manner to prevent pollution of the lake. Lessee shall employ procedures and use equipment that will eliminate or minimize any fire hazard. No production, processing, or any other type of platform can be erected unless approved in writing by Lessor, the United States Coast Guard, and the United States Army Corps of Engineers.

27.4 When and if the area is designated as a primary trawling area, the wellhead shall be fitted with a trawl deflector of approved design. When and if the area is designated for other types of commercial fishing, the wellhead shall be fitted with a protective device of approved design.

27.5 Lessee shall not commingle the production from two or more reservoirs unless specific written permission for such commingling has been granted by Lessor.

27.6 An accepted device (tubing safety valves) approved by Lessor shall be installed below the elevation of the lake bottom on all producing wells in such a manner that will prevent the escape of oil, gas, or water in the event the wellhead equipment is damaged.

27.8 If shown to be more practicable, other completion methods may be used if approved in writing by Lessor.

28. REPAIR OF EQUIPMENT AND PREVENTION OF WASTE

28.1 Lessee shall at all times during the continuance and delivery of oil, gas and liquid hydrocarbons to the market, keep, maintain and repair its pipelines and equipment to the end that there shall be no leaks or waste of oil, gas and liquid hydrocarbons. Lessee shall promptly repair or cause to be repaired any structures or other facilities which may be damaged by his operations.

28.2 Lessee, his agents, contractors and subcontractors, shall not allow any well to blow open, except in case of an emergency, over twenty-four (24) hours after drilling-in. Lessee shall pay Lessor at the regular royalty rate for any gas allowed to escape, except in case of an emergency, after this initial twenty-four (24) hour period. Such gas shall be estimated by a method approved by Lessor in writing.

28.3 After an initial open flow test has been taken, all future determinations of open flow potential shall be made by the United States Bureau of Mines, Back-Pressure Test Method (USBM-Monograph 7) or by other methods standard to the industry and approved by Lessor.

28.4 The determination of the initial open flow of a well shall be made before any attempts are undertaken to increase the flow of such well through mechanical or chemical stimulation.

28.5 At least every six (6) months, Lessee shall determine the open flow of each producing well as required in Section 28.3 and will also take a twenty-four (24) hour reservoir pressure test and shall furnish Lessor with the results of all such tests. Shut-in pressures shall be taken with a deadweight gauge, after a minimum shut-in time period equal to the period required to reach stabilization or twenty-four (24) hours, whichever is the lesser.

29. APPLICABILITY TO OTHER OPERATIONS

29.1 In addition to being applicable to newly drilled wells, the applicable provisions of the foregoing sections shall be in effect for deepening, plug back and conversion operations.

30. TEMPORARY ABANDONMENT

30.1 Lessee shall not temporarily abandon any well without written permission from Lessor. Permission for such temporary abandoment may be granted by Lessor upon written application by Lessee showing sufficient good cause.

30.2 Upon termination of the period of temporary abandonment, Lessee must either resume operations or permanently plug and abandon the well as hereinafter provided.

31. PERMANENT ABANDONMENT

31.1 If a new well is found to be dry or nonproductive, it shall be plugged and abandoned as hereinafter provided. Lessse shall give prior notice to Lessor of the intent to plug and abandon a new well so that plugging operations may be witnessed.

31.2 If a well that has been on production is to be plugged and abandoned, Lessee shall notify Lessor and the Oil and Gas Division, Pennsylvania Department of Mines and Mineral Industries, when actual plugging and abandonment operations are to be started so that they may be witnessed.

31.3 Lessee shall not abandon any well, wells, or lease without having plugged and abandoned such well or wells and effected the adequate restoration of the lake bed. A plugging certificate shall be filed with the Oil and Gas Division, Pennsylvania Department of Mines and Mineral Industries.

32. PLUGGING METHOD

32.1 All wells shall be plugged by filling the hole completely with cement including the inside and annulus of all casing left in the well. Any casing left in the well shall be cut off at the lake bottom or below.

32.2 Lessee shall plug any well in a manner that:

(a) ensures protection for potential oil and gas producing reservoirs;
(b) prevents the harmful infiltration of water into oil, gas, water, or salt formations;
(c) constitutes no hazard to users of the surface;
(d) retains all fluids in their source formations; and
(e) seals off reservoirs from those above and below.

32.3 Lessee shall also plug and abandon all wells on the leased premises in accordance with the requirements of the Pennsylvania Gas Operations, Well Drilling, Petroleum, and Coal Mining Act of 1955 administered by the Oil and Gas Division, Pennsylvania Department of Mines and Mineral Industries, and all other applicable laws of the Commonwealth. A copy of the plugging certificate approved by the Oil and Gas Division shall be supplied to Lessor. Failure to comply with the above plugging requirement will be reason for cancellation of this lease and the posted bond will be forfeited in order that Lessor may properly plug such wells.

34. PRODUCTION AND TRANSPORTATION

34.1 Construction of any permanent or semipermanent structures to be utilized for production, storage, processing, or transportation of any fluids produced from wells must be approved in writing by Lessor, the United States Coast Guard, and the United States Army Corps of Engineers. Detailed plans for any such structures must be submitted to Lessor at least twenty (20) days prior to commencement of construction. No construction shall begin until such plan is approved.

34.2 All platforms utilized for supporting pumping and other equipment shall be firmly anchored in the lake bottom. Such platforms shall be of fabricated steel design of rigid construction able to withstand all adverse weather conditions including moving ice. Such platforms may also be utilized for other operations incident to well operation such as paraffin solvent injection, temporary oil and waste storage, oil and gas processing equipment such as separators, gas heaters, and heater treaters. All such platforms shall be designed in such a manner that will confine any fluids which could escape into the lake thereby causing contamination or pollution in any degree. All platforms shall be approved and marked with suitable navigation markers as required by the United States Coast Guard and United States Army Corps of Engineers.

35. WELL RECORDS, LOGS, AND REPORTS

35.1 Lessee shall keep a daily drilling record which will describe the formations penetrated, depth and volumes of water, oil, gas, and liquid hydrocarbons found while drilling each well on the leased premises. Any other data that is usually acquired in the normal procedure of drilling shall be recorded and furnished to Lessor, such as drilling time, rate of fill-up, lost circulation zones, caving strata, casing records, core analyses, mud log analyses, perforation, and production test data. Within thirty (30) days after completion of each well, Lessee shall furnish Lessor an accurate location plat, a detailed lithologic log, and history of the well including geologic, drillers, electrical, and any other well surveys made to obtain subsurface information In addition, any logs, records, and data pertaining to the completion or treatment of wells shall be made available within thirty (30) days after they are made. A drillers log shall be furnished to the Oil and Gas Division, Pennsylvania Department of Mines and Mineral Industries, in accordance with the requirements of the Pennsylvania Gas Operations, Well Drilling, Petroleum, and Coal Mining Act of 1955. Upon request, samples of all formations penetrated and parts of cores taken, accurately labled with the name of the well, and interval of depth shall be furnished to Lessor at Lessee's expense. Lessee shall also ship a complete sample suite to the Pennsylvania State Geological Survey, State Office Building, 300 Liberty Avenue, Pittsburgh, Pennsylvania 15222, within thirty (30) days after completion of each well.

36. AUDITS

36.1 Lessee shall furnish to Lessor, at its request, the meter charts covering the production of each well on the lease. Lessor may keep such charts for examination for a period not to exceed ninety (90) days. Lessee shall furnish or secure for Department promptly any statements furnished to Lessee by any person or corporation to whom Lessee delivers for sale or transport any oil, gas, and other products produced from the leased premises.

36.2 Lessee further authorizes and directs any person, association, company, partnership, corporation, or other entity to whom Lessee sells or furnishes gas, oil, and liquid hydrocarbons, produced from any well covered by this lease, to disclose and exhibit accounts and other instruments to representatives of Lessor at Lessor's request having to do with the transactions involving payments to Lessee, his heirs, administrators, executors, successors, and assigns for gas, oil, and liquid hydrocarbons from wells covered by this lease.

36.3 Lessee further grants to Lessor the right, at any time, to examine, audit, or inspect books, records, and accounts of Lessee pertinent to the purpose of verifying the accuracy of the reports and statements furnished to Lessor, and for checking the amount of payments lawfully due under the terms of this lease. Lessee agrees to provide every aid or facility to enable such audit to be made by Lessor. If such audit should disclose any gross error or fraud by Lessee in payment of royalties, then Lessee shall pay the cost and expense of said audit together with the deficiency. However, in case of fraud by Lessee, such payments shall not preclude Lessor in his discretion from cancelling this lease upon delivery to Lessee of written notice of Lessor's intention.

37. LESSEE'S TERMINATION

37.1 Lessee may at any time surrender this lease in its entirety or any number of tracts, measuring 1 Minute Latitude by 1 Minute Longitude, and comprising six hundred and thirty (630) acres more or less of the block or blocks leased; provided, however, that such surrender must be evidenced by written notice accompanied by a release or releases in recordable form delivered to Lessor thirty (30) days prior to the effective date thereof, and Lessee has performed all commitments with which Lessee is charged to the effective date of surrender. It is also agreed that any amount paid as an advance bonus, land rental, previous to the effective date of said surrender, shall be deemed liquidated damages due Lessor, and shall be in no way prorated or subject to claim by Lessee for return to Lessee. Under no circumstance and regardless of well spacing requirements, may portions of this lease be surrendered other than on the basis of the tracts described above. Lessee is not then in default of any obligations under this lease.

37.2 In the event that producing wells are to be retained, Lessee shall be entitled to retain that drainage acreage attributable to each well as previously provided under the section entitled "SUBSEQUENT WELLS." Lessee shall deliver to Lessor a release or releases in duly recordable form approved by Lessor. Lessee shall be relieved of all obligations thereafter accruing as to acreage surrendered and any rental thereafter coming due shall be reduced in the same proportion that the acreage covered hereby is reduced; provided, however, that Lessee shall not be relieved of any obligation which accrues prior to such surrender.

38. REMOVAL

38.1 Lessee shall have six (6) months after termination, abandonment, or surrender of this lease, or any part hereof, in which to remove all machinery, well structures, equipment, platforms, pipelines, and other materials and structures resulting from Lessee's operations.

39. RELEASE

39.1 Lessee shall not be granted a final release from the terms of this lease until an inspection of the leased premises by Lessor indicates the proper removal procedure has been completed.

40 ABANDONMENT AND STORAGE RIGHTS

40.1 In the event the development of this lease demonstrates, in the opinion of Lessor, that this tract has potential value as a gas storage reservoir (no storage rights are demised to Lessee under the terms of this lease), before any well shall be plugged, the well, equipment, property, and casing involved shall first be offered to Lessor, his nominee or assignee, at the then fair market value of those items. Such firm offer shall be made in writing to Lessor at least thirty (30) days prior to commencement of removal of the equipment from the well by Lessee.

41. LESSOR'S TERMINATION

41.1 If Lessee shall fail or refuse to pay any rental or royalty due under the terms of this lease within thirty (30) days after demand in writing by Lessor, of if Lessee shall violate, or fail to perform any of the covenants or provisions of this lease, Lessor shall have the right to terminate the lease.

41.2 In case of default in the payment of any sum of money due under the provisions of this lease within thirty (30) days after demand in writing by Lessor or the breach of any other of the terms of this lease, Lessee hereby authorizes and empowers the Attorney General of the Commonwealth of Pennsylvania, or any attorney of any court of record to appear for it in an amicable action of ejectment for the leased premises above described, to be entered by the Prothonotary in which said Lessor shall be plaintiff and said Lessee defendant and confess judgment therein in favor of the plaintiff and against the defendant for the said leased premises and authorize the immediate issuing of a writ of Habre Facias Possessionem (without asking leave of court) waiving all stay and exemption laws and release of errors.

42. INDEMNITY

42.1 Lessee shall, at all times, hereinafter indemnify and save harmless Lessor from and against all detriment, damage, loss, claims, demands, suits, and expenses, or other claims of any kind whatsoever, which the said Lessor may sustain, suffer, or be subject to directly or indirectly by reason of location, obstruction, presence, maintenance, renewal, or removal of said operations permitted by this agreement or resulting therefrom.

43. BOND

Lessee agrees to give Lessor a surety or performance bond with satisfactory corporate surety in the principal sum of Forty Thousand Dollars ($40,000.00) at the time this lease is executed. Lessee shall also give Lessor a surety bond with satisfactory corporate surety in the principal sum of Twenty Thousand Dollars ($20,000.00) prior to the commencement of each and every well drilled on the leased premises. Upon the satisfactory permanent abandonment of each and every well and the adequate restoration of the affected area of the lake, the bond deposited will be reduced by the principal sum of Twenty Thousand Dollars ($20,000.00). Each bond shall have a judgment clause in a form to be approved by the Attorney General conditioned on the faithful performance of the covenants of this lease. Said bonds shall be further conditioned that in the event Lessee shall fail to remove his equipment and machinery and properly abandon said well or wells, Commonwealth can execute upon said bonds to pay for the cost of removal of said equipment and machinery and proper abandonment of said well or wells. In addition, each bond shall be conditioned in favor of the Commonwealth for all damages that may arise as a result of fires, accidents, or any other causes brought about by Lessee or Lessee's agents occupying the leased premises.

44. INSURANCE

44.1 Lessee shall maintain in force an insurance policy of One Million Dollars ($1,000,000.00) which will cover accident and property damage liability resulting from each adverse occurrence or accident which may occur during any operation, including but not limited to exploration, drilling, producing, and delivering the well product conducted pursuant to this lease.

45. RELATED AGREEMENTS

45.1 Lessor will be furnished for record purposes and to protect his interests a copy of all agreements, contracts, letters, or memoranda entered into, made, or sent by Lessee in any way concerning the development, operation, or sale of products from this lease.

46. ASSIGNMENTS

46.1 Lessee shall not use or allow to be used, the leased premises for any other purpose than authorized by this instrument, and shall not assign or sublet, the leased premises in whole or in part at any time, or from time to time, without the prior written consent of Lessor. Lessee shall make application to obtain such consent in writing accompanied by a plat to Lessor describing the land to be assigned and the interest therein if less than the whole, together with the interest retained by assignor. Assignee shall agree in writing to be bound by all of the terms and provisions of the lease, and shall furnish a surety or performance bond satisfactory to Lessor. After Lessor has consented to the assignment, assignor shall be released from all liability under this lease arising or accruing subsequent to the date of such assignment as to the part or parts so assigned, and assignee, thereof, shall, thereupon, be deemed to have assumed and be responsible for the covenants, conditions, and obligations of this lease as to the part or parts assigned. In the event that a portion only of the leased premises is assigned, the default of any of the covenants, conditions, or obligations of this lease by one of the holders of a portion of the leased premises created by an assignment, will not affect the interests of a party not in default.

47. LIMITATION ON WARRANTY

47.1 The Commonwealth is considered to be the owner of the oil and gas rights under the leased premises, but makes no warranty as to the presence of oil and gas. In the event of an adverse claim to the premises affecting title to all or a portion of the oil and gas rights under the leased premises, notice of such claim will be given to Lessor who may with the approval of the Attorney General enter into an escrow arrangement for future rents and royalties accruing to such disputed portion under terms and conditions that he feels proper to safeguard the rights and interests of the Commonwealth. In the event an adverse claimant files suit against the Commonwealth or against Lessee, claiming title to all or a portion of the oil or gas rights under the leased premises, or if Lessee, after receiving notice of an adverse claim, institutes litigation in a court of competent jurisdiction to secure an adjudication of the validity of the claim, the rents and royalties accruing to the litigated portion shall be placed in an escrow account, until such time as the ownership of the disputed interest shall be determined by a court of competent jurisdiction. The rents and royalties placed in escrow shall be refunded to Lessee in an amount proportionate to the outstanding title if it is finally determined by compromise or by a court of competent jurisdiction that all or part of such rights are not owned by the Commonwealth.

48. FORCE MAJEURE

48.1 This lease shall not be terminated, in whole or in part, nor shall Lessee be held liable for damages, for failure to comply with express or implied covenants hereof if compliance, therewith, is prevented by or if such failure is the result of any Federal or State laws, executive orders, rules or regulations whether valid or invalid. If at the end of the primary term, hereof, such term has not been extended by production or drilling as in this lease provided and Lessee by reason of any of the above recited causes is unable to drill a well on the leased premises for oil or gas, the primary terms and the rental provision, hereof, shall be extended automatically from year to year for a period not to exceed ten (10) additional years unless further extension is approved by Lessor in writing so long as Lessee meets all requirements for payments of money and other obligations to Lessor; provided, however, upon the removal of such delaying cause, Lessee must commence operations within six (6) months after such removal. During any period that Lessee is unable to produce and/or market any products from the leased premises by reason of any of the above recited causes, this lease shall remain in force and effect.

IT IS HEREBY MUTUALLY UNDERSTOOD AND AGREED that this lease shall be legally binding on the parties hereto, their heirs, administrators, executors, successors, and assigns.

IN WITNESS WHEREOF, Lessor and Lessee have caused this lease to be duly executed and have caused their seals to be hereto affixed and attached by their proper officer, all hereunto duly authorized, on the date first above written.

ATTEST:

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS

____

By________________________________
Secretary

ATTEST:

____

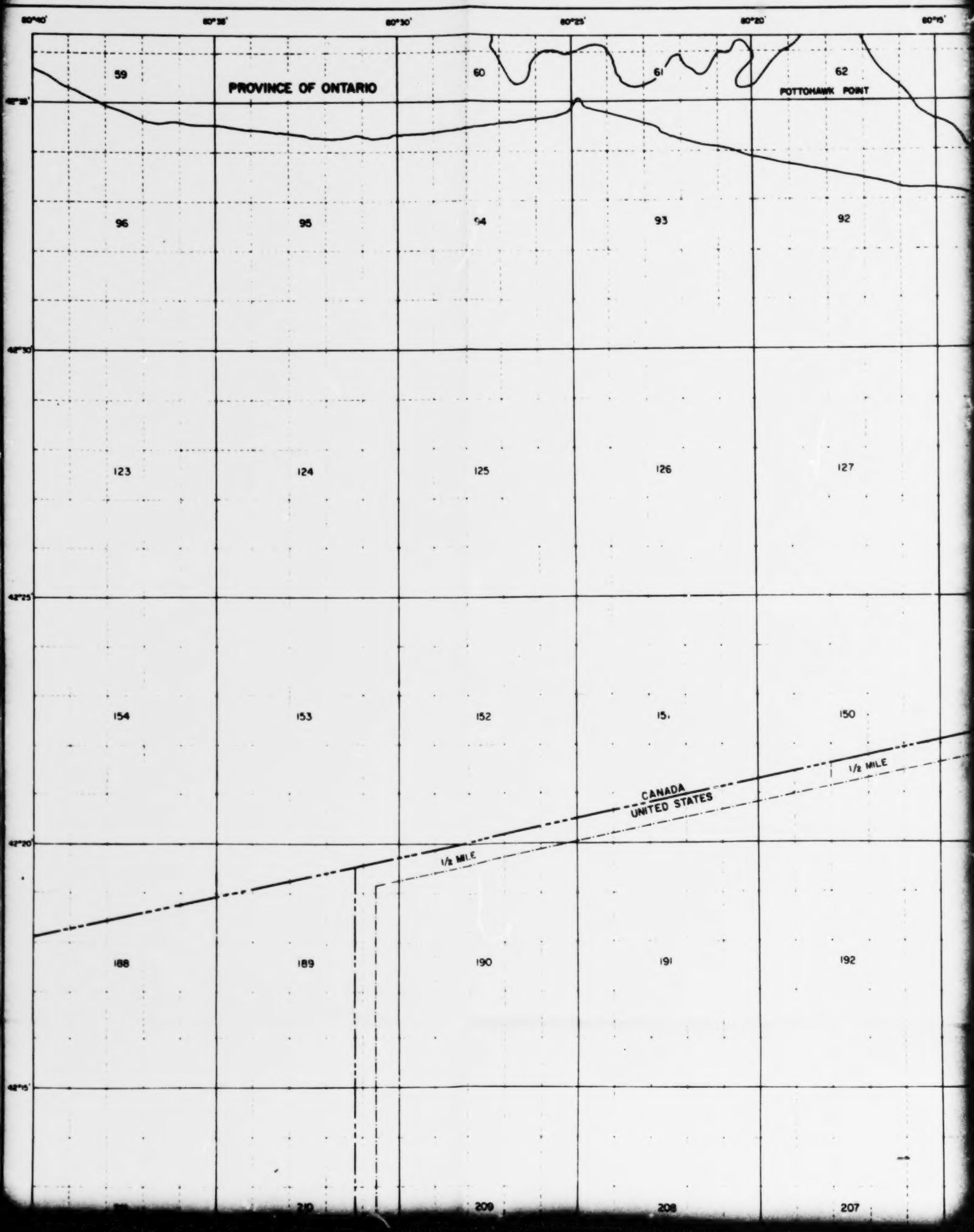
By________________________________(Seal)
Authorized Agent

APPROVED AS TO MANNER AND
FORM OF EXECUTION:

____
Assistant Attorney General

APPROVED:

____
Governor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80°20'
80°15'
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42°30'
42°25'
42°20'
42°15'
PROVINCE OF ONTARIO
POTTOHAWK POINT
59
60
61
62
96
95
94
93
92
123
124
125
126
127
154
153
152
151
150
CANADA
UNITED STATES
1/2 MILE
1/2 MILE
188
189
190
191
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210
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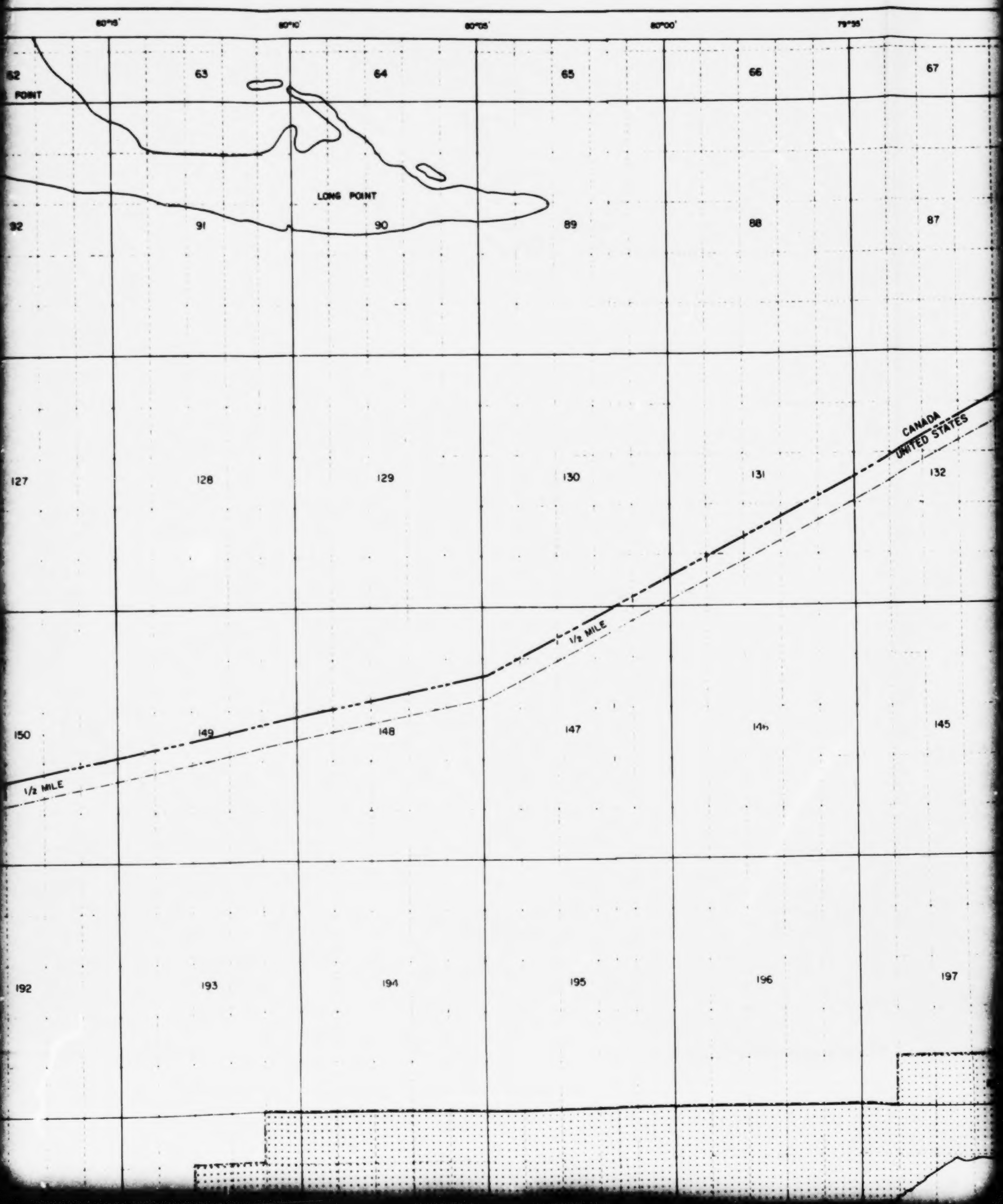
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80°05'
80°00'
79°55'
62
63
64
65
66
67
POINT
LONG POINT
92
91
90
89
88
87
127
128
129
130
131
132
CANADA
UNITED STATES
1/2 MILE
1/2 MILE
150
149
148
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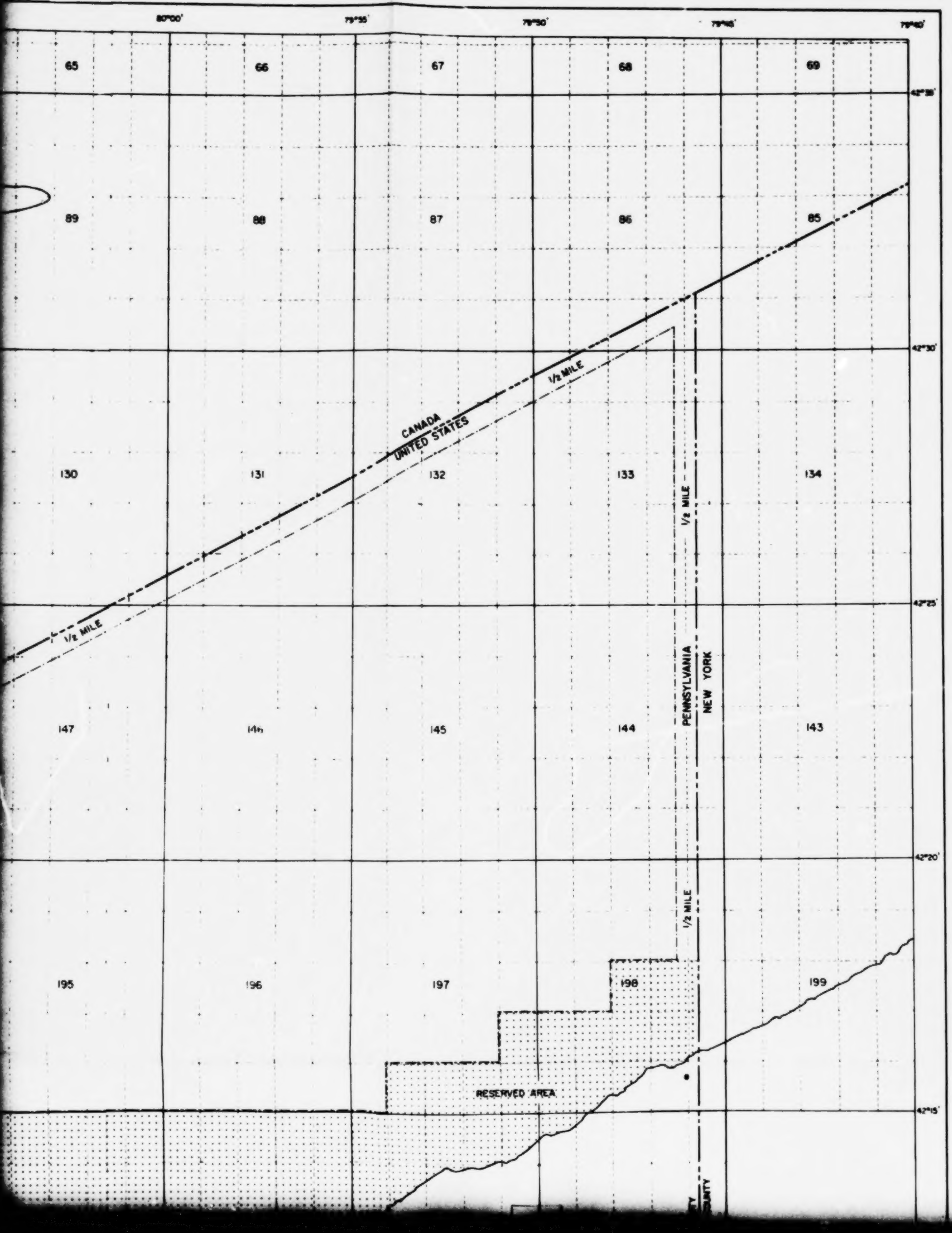
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42°35'
42°30'
42°25'
42°20'
42°15'
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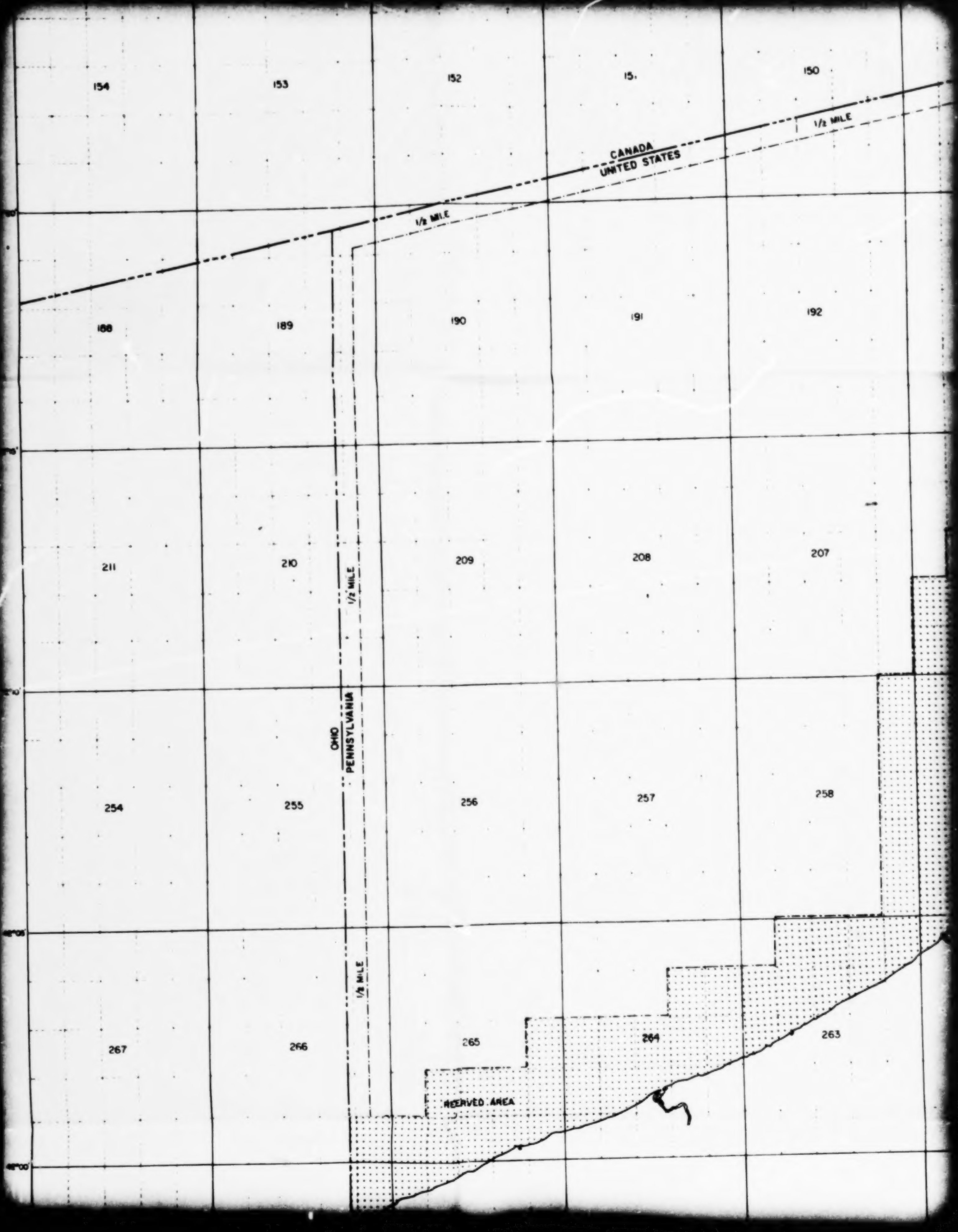
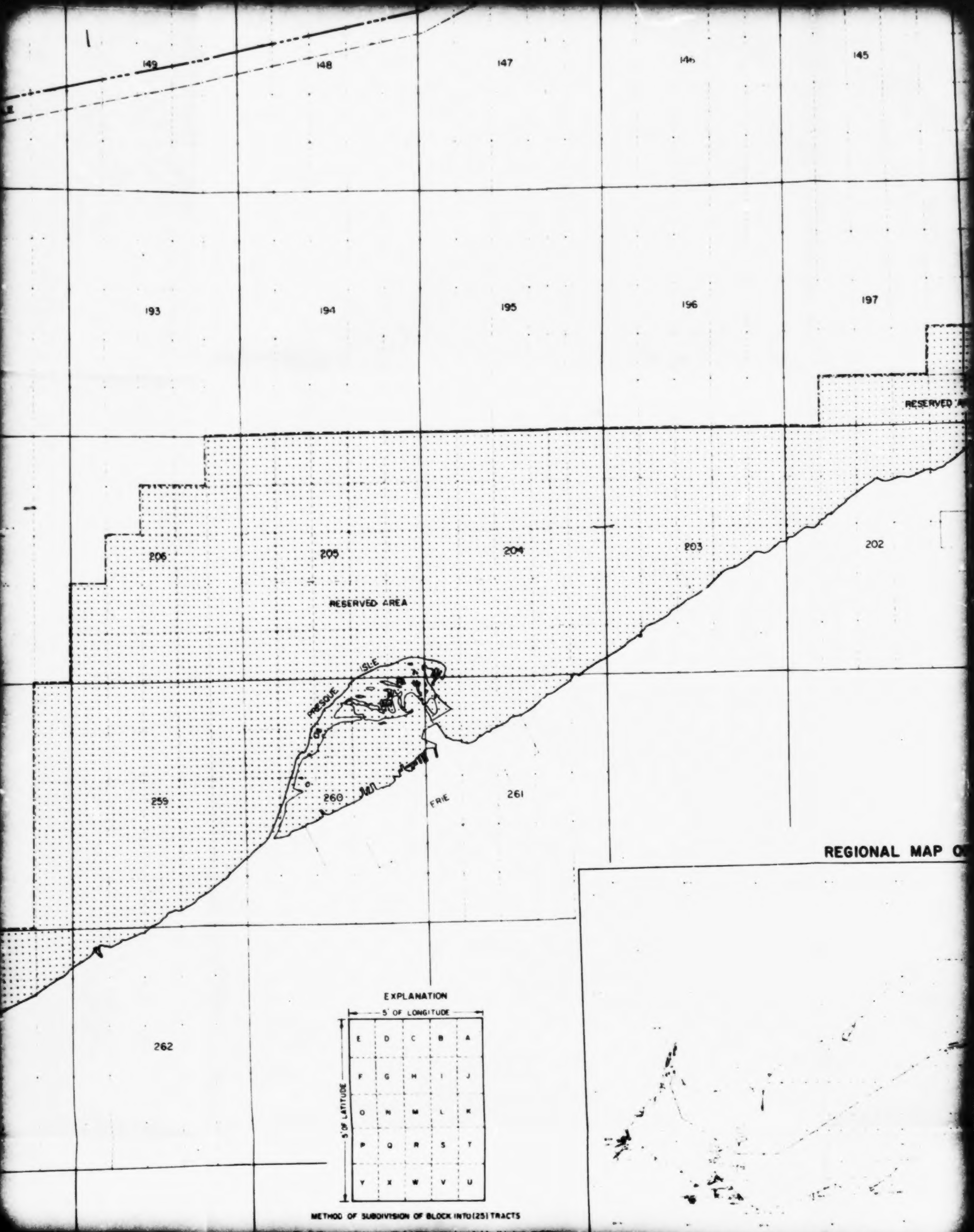
CANADA
UNITED STATES
1/2 MILE
1/2 MILE
1/2 MILE
1/2 MILE
PENNSYLVANIA
NEW YORK
RESERVED AREA

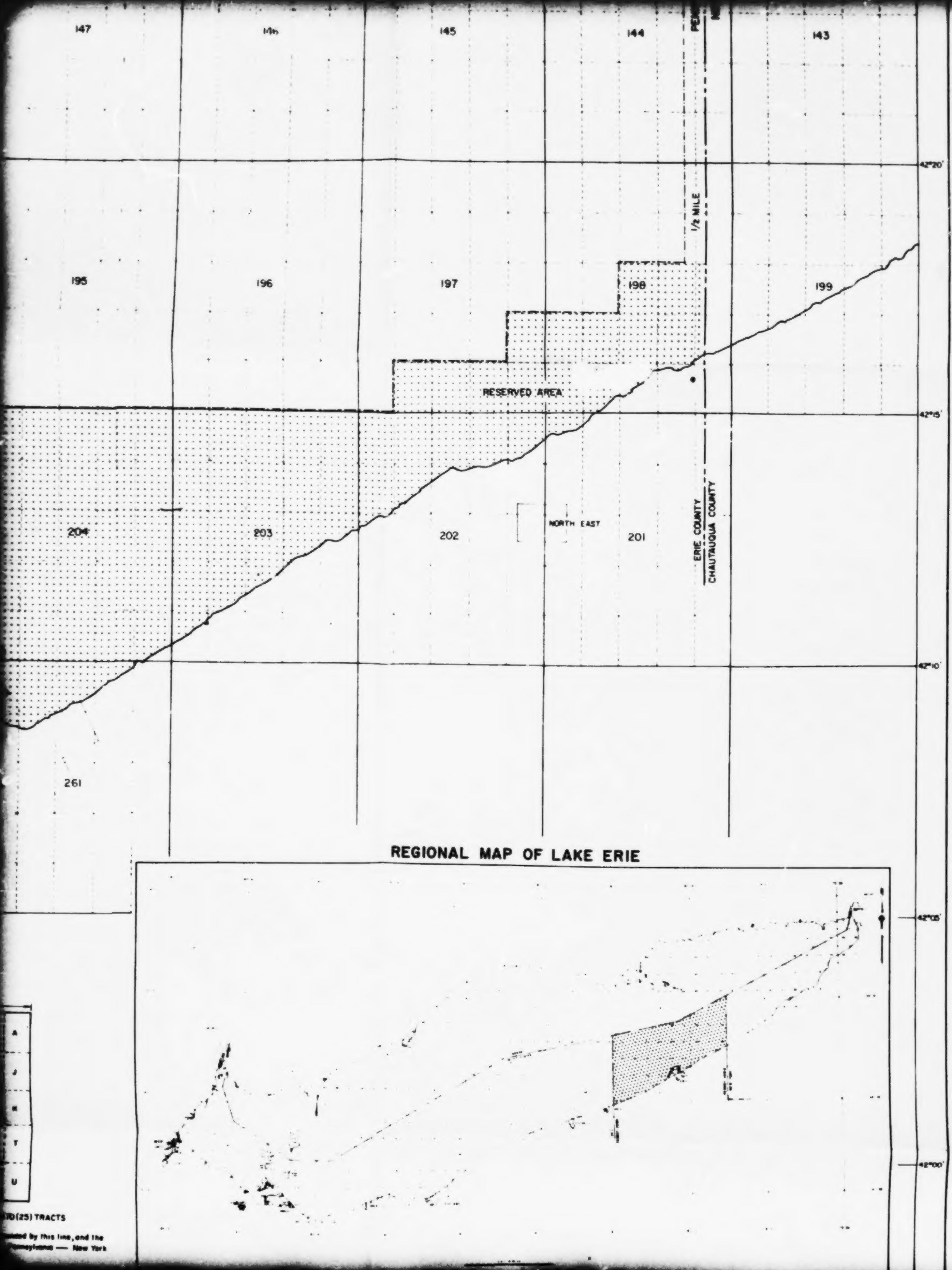

154
153
152
151
150
CANADA
UNITED STATES
1/2 MILE
1/2 MILE
188
189
190
191
192
211
210
209
208
207
1/2 MILE
OHIO
PENNSYLVANIA
254
255
256
257
258
1/2 MILE
267
266
265
264
263
RESERVED AREA



149
148
147
146
145
193
194
195
196
197
RESERVED AR
206
205
204
203
202
RESERVED AREA
PRESQUE ISLE
259
260
ERIE
261
262
EXPLANATION
5' OF LONGITUDE
5' OF LATITUDE
E D C B A
F G H I J
O N M L K
P Q R S T
Y X W V U

METHOD OF SUBDIVISION OF BLOCK INTO (25) TRACTS

REGIONAL MAP O


147
146
145
144
143
PENN
N.Y.
1/2 MILE
42°20'
195
196
197
198
199
RESERVED AREA
42°15'
204
203
202
NORTH EAST
201
ERIE COUNTY
CHAUTAUQUA COUNTY
42°10'
261
REGIONAL MAP OF LAKE ERIE
42°05'
42°00'
A
J
K
T
U
10(25) TRACTS
nded by this line, and the
Pennsylvania — New York

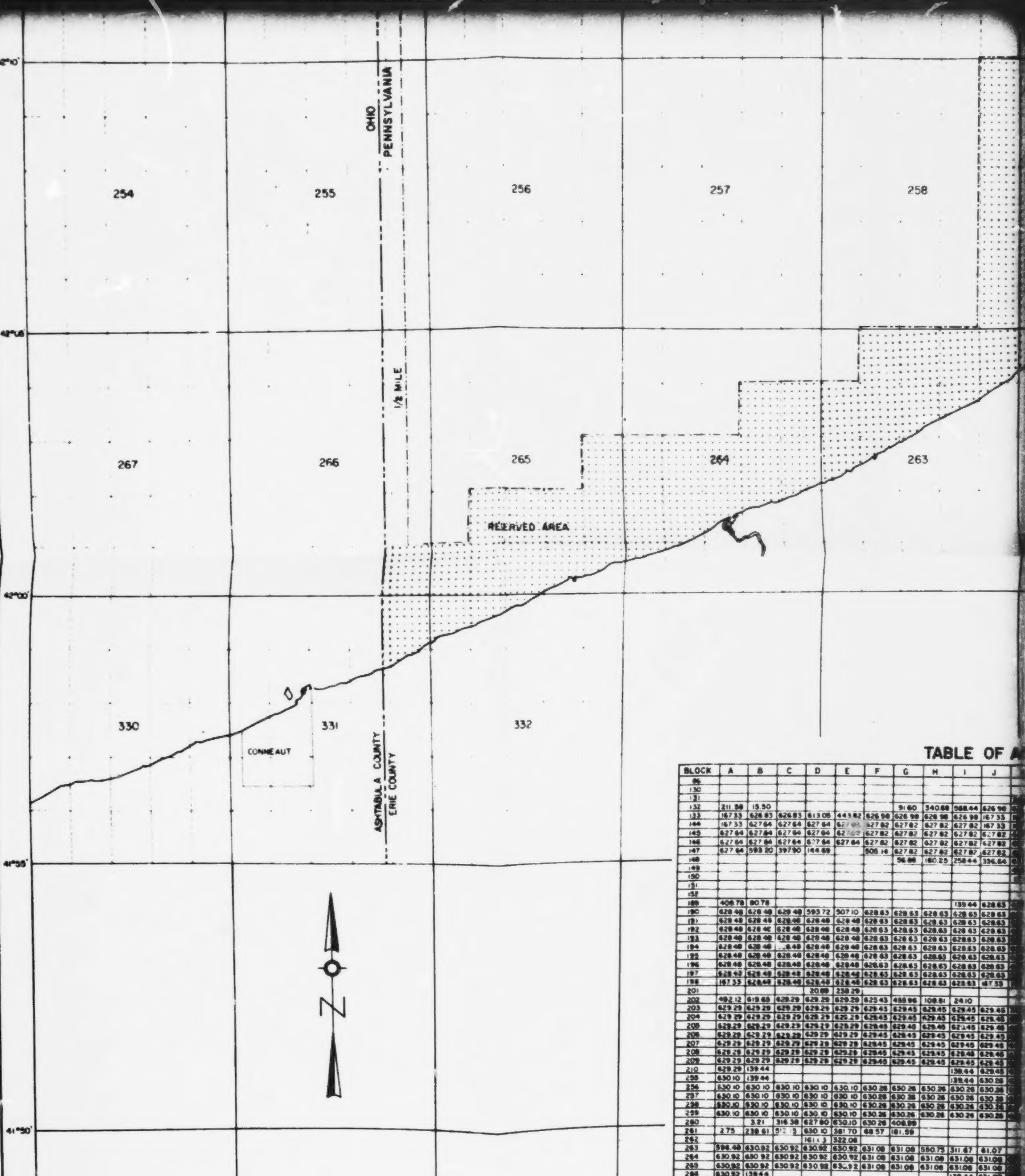
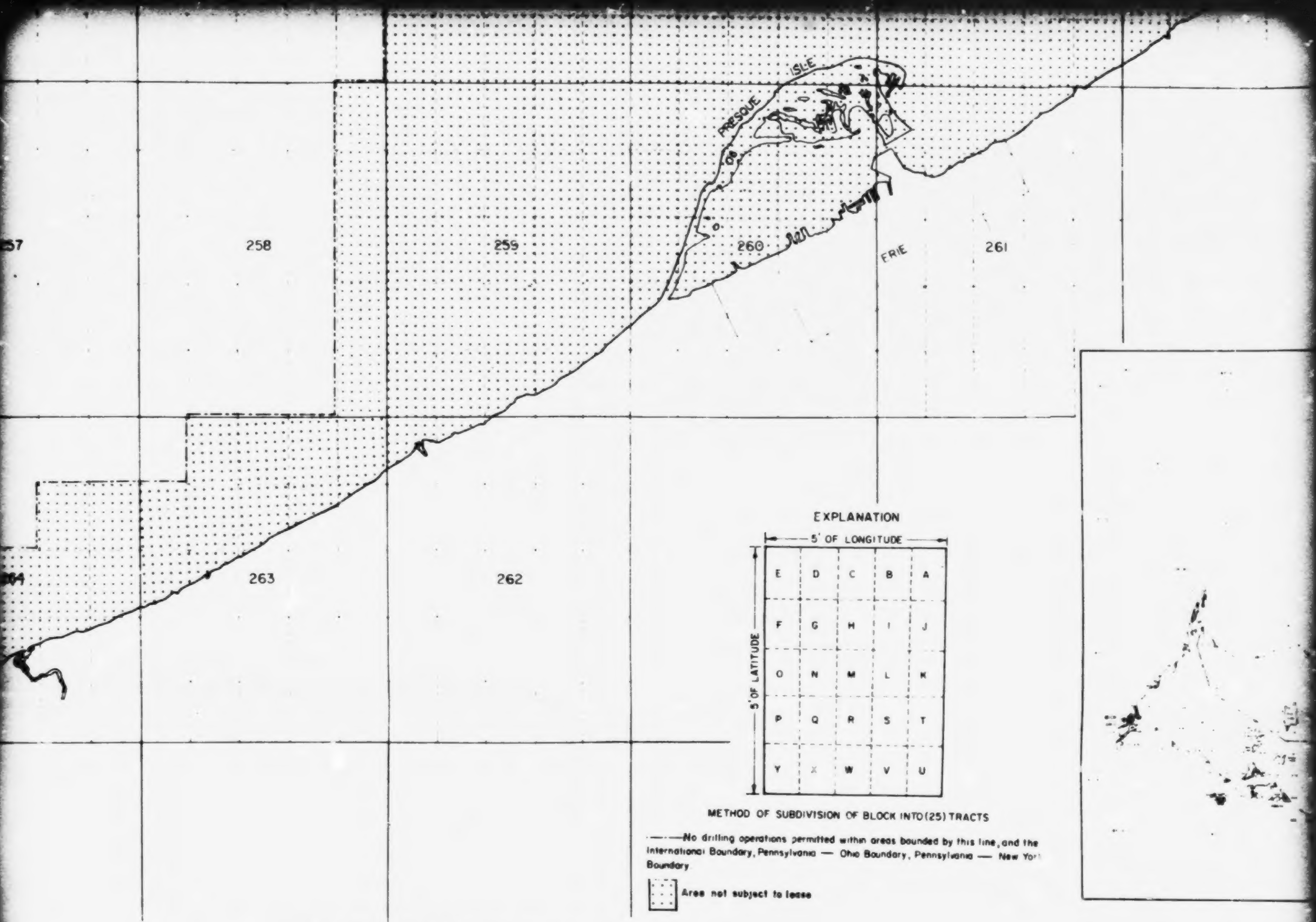


TABLE OF A

BLOCK	A	B	C	D	E	F	G	H	I	J
86										
130										
131										
132	211.98	15.50					91.60	340.88	588.44	626.98
133	167.33	626.83	626.83	613.08	443.82	626.98	626.98	626.98	626.98	167.33
144	167.33	627.64	627.64	627.64	627.64	627.82	627.82	627.82	627.82	167.33
145	627.64	627.64	627.64	627.64	627.64	627.82	627.82	627.82	627.82	627.82
146	627.64	627.64	627.64	627.64	627.64	627.82	627.82	627.82	627.82	627.82
147	627.64	593.20	397.90	144.69		505.14	627.82	627.82	627.82	627.82
148							56.86	160.25	258.44	336.64
149										
150										
151										
152										
189	408.78	80.78							139.44	628.63
190	628.48	628.48	628.48	593.72	507.10	628.63	628.63	628.63	628.63	628.63
191	628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63
192	628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63
193	628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63
194	628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63
195	628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63
196	628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63
197	628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63
198	167.33	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	167.33
201				20.88	238.29					
202	492.12	619.68	629.29	629.29	629.29	625.43	495.96	108.81	24.10	
203	629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45
204	629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45
205	629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45
206	629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45
207	629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45
208	629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45
209	629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45
210	629.29	139.44							139.44	629.45
255	630.10	139.44							139.44	630.26
256	630.10	630.10	630.10	630.10	630.10	630.26	630.26	630.26	630.26	630.26
257	630.10	630.10	630.10	630.10	630.10	630.26	630.26	630.26	630.26	630.26
258	630.10	630.10	630.10	630.10	630.10	630.26	630.26	630.26	630.26	630.26
259	630.10	630.10	630.10	630.10	630.10	630.26	630.26	630.26	630.26	630.26
260		3.21	316.38	627.80	630.10	630.26	408.89			
261	2.75	238.61	512.13	630.10	381.70	68.57	181.59			
262				161.13	322.08					
263	398.48	630.92	630.92	630.92	630.92	631.08	631.08	580.75	311.67	61.07
264	630.92	630.92	630.92	630.92	630.92	631.08	631.08	631.08	631.08	631.08
265	630.92	630.92	630.92	630.92	630.92	631.08	631.08	631.08	631.08	631.08
266	630.92	139.44							139.44	631.08
331	620.71	139.44							47.06	78.78
332			89.42	291.22	468.03					



EXPLANATION

METHOD OF SUBDIVISION OF BLOCK INTO (25) TRACTS

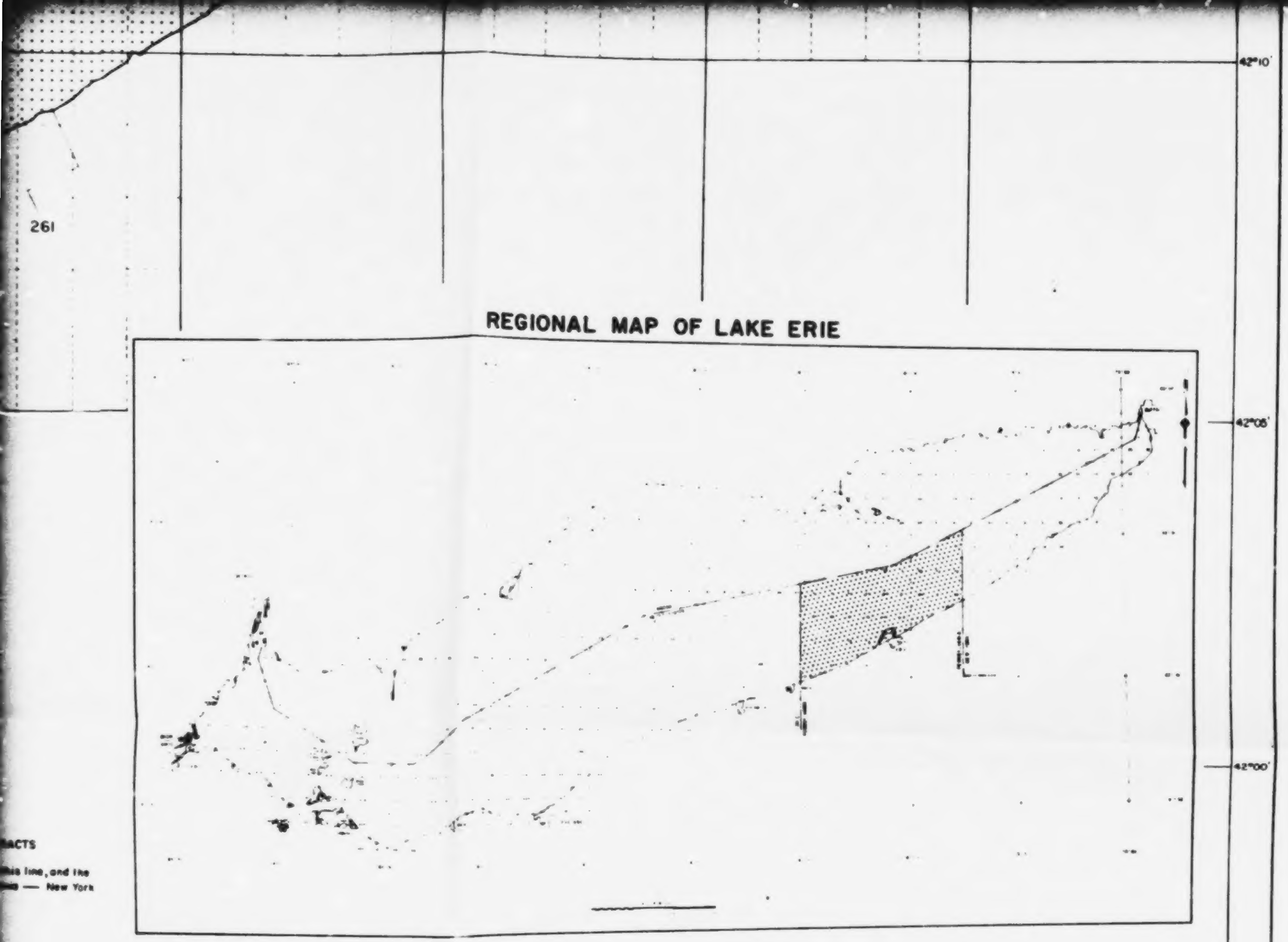
No drilling operations permitted within areas bounded by this line, and the International Boundary, Pennsylvania — Ohio Boundary, Pennsylvania — New York Boundary

Area not subject to lease

TABLE OF ACREAGE BY BLOCK AND TRACT

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	TOTAL ACRES
																			10.46	167.33	514.61	278.62	53.37		1,024.38
																				247.99	27.78				275.77
										211.68	17.56					95.96	346.07	575.67	627.32	627.48	627.48	627.48	624.73	495.98	4,877.41
211.98	15.50					91.80	340.88	568.44	626.98	627.14	627.14	627.14	623.96	459.51	627.32	627.32	627.32	627.32	627.32	627.48	627.48	627.48	627.48	627.48	11,003.67
167.33	626.83	626.83	613.05	443.82	626.98	626.98	626.98	626.98	167.33	167.33	627.14	627.14	627.14	627.14	627.32	627.32	627.32	627.32	167.33	167.33	627.48	627.48	627.48	627.48	13,182.86
167.33	627.64	627.64	627.64	627.64	627.82	627.82	627.82	627.82	167.33	167.33	627.98	627.98	627.96	627.98	628.14	628.14	628.14	628.14	167.33	167.33	628.32	628.32	628.32	628.32	13,396.25
627.64	627.64	627.64	627.64	627.64	627.82	627.82	627.82	627.82	627.82	627.98	627.98	627.98	627.98	627.98	628.14	628.14	628.14	628.14	628.14	628.32	628.32	628.32	628.32	628.32	15,699.50
627.64	627.64	627.64	627.64	627.64	627.82	627.82	627.82	627.82	627.82	627.98	627.98	627.98	627.98	627.98	628.14	628.14	628.14	628.14	628.14	628.32	628.32	628.32	628.32	628.32	15,699.50
627.64	593.20	397.90	144.69		506.14	627.82	627.82	627.82	627.82	627.98	627.98	627.98	627.98	627.98	628.14	628.14	628.14	628.14	628.14	628.32	628.32	628.32	628.32	628.32	14,202.06
						56.86	160.23	258.44	356.64	627.98	627.98	627.98	627.98	588.02	628.14	628.14	628.14	628.14	628.14	628.32	628.32	628.32	628.32	628.32	10,214.41
										496.31	408.42	320.53	217.13	113.74	628.14	628.14	628.14	628.14	628.14	628.32	628.32	628.32	628.32	628.32	7,838.43
										17.91					237.92	336.19	434.46	537.91	618.96	628.32	628.32	628.32	628.32	628.32	5,324.95
																		41.38	134.48	628.32	628.32	568.84	465.60	367.32	2,834.26
																				274.19	170.72	60.08			504.99
408.75	80.78							139.44	628.63	628.79	139.44							139.44	628.95	629.13	139.44				3,562.79
628.48	628.48	628.48	593.72	507.10	628.63	628.63	628.63	628.63	628.63	628.79	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	628.95	629.13	629.13	629.13	629.13	629.13	15,563.76
628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63	628.79	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	628.95	629.13	629.13	629.13	629.13	629.13	15,719.90
628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63	628.79	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	628.95	629.13	629.13	629.13	629.13	629.13	15,719.90
628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63	628.79	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	628.95	629.13	629.13	629.13	629.13	629.13	15,719.90
628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63	628.79	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	628.95	629.13	629.13	629.13	629.13	629.13	15,719.90
628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63	628.79	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	628.95	629.13	629.13	629.13	629.13	629.13	15,719.90
628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63	628.79	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	628.95	629.13	629.13	629.13	629.13	629.13	15,719.90
628.48	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	628.63	628.79	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	628.95	629.13	629.13	629.13	629.13	629.13	15,719.90
167.33	628.48	628.48	628.48	628.48	628.63	628.63	628.63	628.63	167.33	167.33	628.79	628.79	628.79	628.79	628.95	628.95	628.95	628.95	140.50		59.13	258.90	552.17	629.13	12,201.22
			20.89	238.29																					259.18
492.12	619.68	629.29	629.29	629.29	625.43	455.96	109.81	24.10						80.00											4,293.94
629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45	310.95	533.65	629.61	629.61	629.61	629.76	550.21	243.63	5.62					12.40	259.24	10,727.99
629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45	629.61	629.61	629.61	629.61	629.61	629.76	629.76	629.76	629.76	629.76	556.49	629.95	629.95	629.95	564.29	15,601.18
629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45	629.61	629.61	629.61	629.61	629.61	629.76	629.76	629.76	629.76	629.76	418.24	556.49	629.95	629.95	629.95	15,455.13
629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45	629.61	629.61	629.61	629.61	629.61	629.76	629.76	629.76	629.76	629.76	629.95	629.95	629.95	629.95	629.95	15,740.30
629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45	629.61	629.61	629.61	629.61	629.61	629.76	629.76	629.76	629.76	629.76	629.95	629.95	629.95	629.95	629.95	15,740.30
629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45	629.61	629.61	629.61	629.61	629.61	629.76	629.76	629.76	629.76	629.76	629.95	629.95	629.95	629.95	629.95	15,740.30
629.29	629.29	629.29	629.29	629.29	629.45	629.45	629.45	629.45	629.45	629.61	629.61	629.61	629.61	629.61	629.76	629.76	629.76	629.76	629.76	629.95	629.95	629.95	629.95	629.95	15,740.30
629.29	139.44							139.44	629.45	629.61	139.44							139.44	629.76	629.95	139.44				3,845.26
630.10	139.44							139.44	630.26	630.44	139.44							139.44	630.60	130.76	139.44				3,349.36
630.10	630.10	630.10	630.10	630.10	630.26	630.26	630.26	630.26	630.26	630.44	630.44	630.44	630.44	630.44	630.60	630.60	630.60	630.60	630.60	630.76	630.76	630.76	630.76	630.76	15,760.80
630.10	630.10	630.10	630.10	630.10	630.26	630.26	630.26	630.26	630.26	630.44	630.44	630.44	630.44	630.44	630.60	630.60	630.60	630.60	630.60	630.76	630.76	630.76	630.76	630.76	15,760.80
630.10	630.10	630.10	630.10	630.10	630.26	630.26	630.26	630.26	630.26	630.44	630.44	630.44	630.44	630.44	630.60	630.60	630.60	630.60	630.60	630.76	630.76	630.76	630.76	630.76	15,760.80
630.10	630.10	630.10	630.10	630.10	630.26	630.26	630.26	630.26	630.26	630.44	630.44	630.44	630.44	630.44	630.60	630.60	630.60	630.60	562.42	27.55	280.35	505.26	630.76	630.76	14,613.50
	3.21	316.38	627.80	630.10	630.26	408.99							61.07	604.81	154.27										3,436.69
2.75	238.61	512.15	630.10	381.70	69.57	181.59																			2,015.47
			161.03	322.06																					483.09
598.46	630.92	630.92	630.92	630.92	631.08	631.08	550.73	311.67	61.07			7.58	192.26	431.29											5,938.92
630.92	630.92	630.92	630.92	630.92	631.08	631.08	631.08	631.08	631.08	608.53	631.26	631.26	631.26	631.26	631.42	603.64	391.54	187.11	31.57				26.40	176.75	11,492.00
630.92	630.92	630.92	630.92	630.92	631.08	631.08	631.08	631.08	631.08	631.26	631.26	631.26	631.26	631.26	631.42	631.42	631.42	631.42	631.42	309.80	482.98	630.28	631.57	631.57	15,305.14
630.92	139.44							139.44	631.08	631.26	139.44							139.44	631.42	631.57	139.44				3,853.45
620.71	139.44							47.06	79.76																882.97
		89.42	291.22	468.03																					848.67
																									480,179.04

80°20' 80°15' 80°10' 80°05' 80°00'


261
42°10'
42°05'
42°00'
REGIONAL MAP OF LAKE ERIE
ACTS
his line, and the
— New York
CRES

INTERNATIONAL BOUNDARY GEODETIC COORDINATES

TP	42°49'41.616"	78°56'08.131"
TP	42°23'36.530"	80°04'48.334"
TP	42°12'26.973"	81°14'44.919"

PENNSYLVANIA-OHIO BOUNDARY GEODETIC COORDINATES

NW Corner 41°58'21.48" 80°31'10.6"

PENNSYLVANIA-NEW YORK BOUNDARY COORDINATES

N E Corner 42°16'05.39" 79° ' 44.00"

LOW WATER DATUM (1965) 568.6'

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
DIVISION OF MINERALS

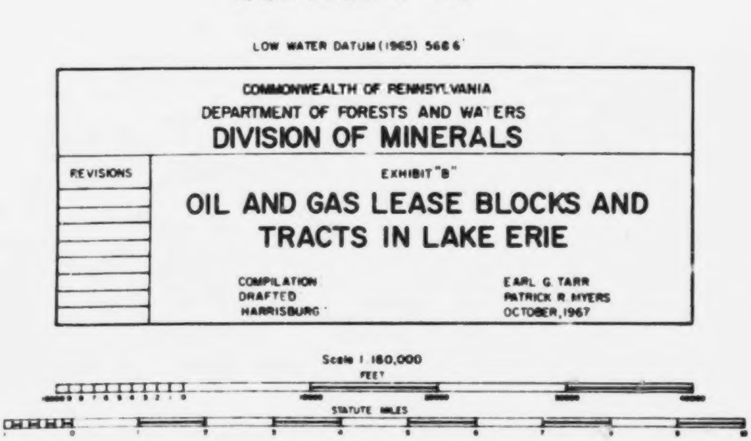
REVISIONS

EXHIBIT "B"

OIL AND GAS LEASE BLOCKS AND TRACTS IN LAKE ERIE

COMPILATION	EARL G. TARR
DRAFTED	PATRICK R. MYERS
HARRISBURG	OCTOBER, 1967

Scale 1:180,000


FEET
STATUTE MILES
0
1
2
3
4
5
6
7
8
9
10
41°55'
41°50'

SOURCE OF DATA
U.S. Army Corps of Engineers
U.S. Coast & Geodetic Survey
Pa. Department of Internal Affairs

Modified after U.S. Army Corps of Engineer's Survey of Lake Erie Charts No 3, May 1965, No 32, Oct 1965, No 33, July 1965

80°00'
79°55'
79°50'
79°45'
79°40'

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS

OIL AND NATURAL GAS LEASE FOR THE LANDS BENEATH LAKE ERIE ATTACHMENT

EXHIBIT "C"

Attached to and made a part of Oil and Natural Gas Lease For The Lands Beneath Lake Erie, No. , by and between: COMMONWEALTH OF PENNSYLVANIA and

STIPULATIONS FOR THE PROTECTION AND CONSERVATION OF THE SUBMERGED LANDS AND THE WATERS OF LAKE ERIE

1. PROTECTION AND CONSERVATION

1.1 It is hereby fully and mutually understood and agreed that no rights are granted in this lease which shall in any way be so construed as to impair the powers or duties of the Commonwealth or its representatives in the execution of the laws of the Commonwealth, having particular reference to the control, protection, maintenance, development and use of the submerged lands of Lake Erie and the waters covering these lands. Lessor shall have the right at any time to take any measures necessary for the control, protection, maintenance, development, and use of the submerged lands of Lake Erie and the waters covering these lands. This right includes but is not limited to the proper conservation and utilization of the oil and gas resources indigenous to these lands and the prevention of pollution and contamination of the waters of Lake Erie. Lessee shall not use or allow to be used the leased premises for any other purpose than that authorized by this lease. Lessee shall conduct all operations with deference to the purposes to which the leased premises are dedicated as set forth in the health, park, water, fish, and game laws, rules and regulations of the Commonwealth of Pennsylvania and in particular agrees to the following:

1.2 Lessee shall be familiar with and abide by all applicable laws, rules and regulations of the Water and Power Resources Board, and the Sanitary Water Board of the Commonwealth of Pennsylvania, the United States Army Corps of Engineers, and the United States Coast Guard. Any and all operations of Lessee must be approved by and carried out in accordance with all applicable laws, rules and regulations of the said agencies and Lessee shall promptly comply with any specific rulings by the said agencies concerning his operations.

1.3 Lessee shall be familiar with and comply with the objectives for Boundary Waters Quality Control established by the International Joint Commission and approved by the Governments of Canada and the United States.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
HARRISBURG, PENNSYLVANIA

PRESS RELEASE 68-14
MARCH 14, 1968
Page One

FOR IMMEDIATE RELEASE

HARRISBURG - Maurice K. Goddard, Secretary of Forests and Waters, announced that his Department is requesting sealed bids for the leasing of thirty-seven (37) offshore oil and gas lease blocks in Lake Erie, comprising 369,989 acres.

The proposals will be received until 2 p.m., EST, Tuesday, April 9, 1968, at Room 409-A, Education Building, Harrisburg, Pennsylvania.

Forms of the required bid proposal, the lease agreement, and a map showing the location of the lease blocks, may be obtained from the Department of Forests and Waters, Division of Minerals, Room 408, Education Building, Harrisburg, Pennsylvania 17120.

Drilling and production regulations for the lake that will assure the orderly development of the oil and gas resources - chances of finding oil are minimal, protect Lake Erie from pollution and preserve both public and private interests - have been developed and incorporated into the Department's lease for the lake.

The strict requirements and rigid guarantees contained in the Department's lease were developed over a twenty-month period beginning in July, 1966. They are the result of joint discussions held and information exchanged between the Department and representatives of Ohio, New York, and the Province of Ontario, along with other State and Federal agencies having jurisdiction over the lake. Periodic meetings will be held in the future to maintain close liaison, to assure that all rules and regulations are adhered to, and to develop any new measures necessary for the control and protection of the lake's resources.

Some strong lease provisions for the protection and conservation of the lake's resources are:

1. Prior to beginning any operations, plans of the proposed operations must be approved by the Department and all other State and Federal authorities having jurisdiction over the lake.
2. The Department retains the right at any time to take any measure necessary for the control, protection, maintenance, development, and use of the submerged lands and waters of Lake Erie, including the proper conservation and utilization of the oil and gas resources and the prevention of pollution of the waters of the lake.
3. No pollution or contamination of the lake in any manner whatsoever

is permitted and all deleterious substances must be disposed of onshore in accordance with the laws of the Commonwealth.

4. Any operation which is a source or potential source of pollution will be stopped by the Department until it is determined that no pollution will occur.

5. Reimbursement must be made for all damage or destruction of property including shoreline, life, and the waters of Lake Erie.

6. For this purpose and to provide for proper abandonment, a permanent bond of $40,000 is to be maintained. In addition, a $20,000 bond must be provided prior to the commencement of any well. A $1,000,000 insurance policy is to be maintained that will cover accident and property liability resulting from each adverse occurrence or accident during any operations.

7. Drilling mud of sufficient weight, capable of controlling formation pressures, and preventing oil and gas blowouts or flows of fresh water must be available at all times.

8. All casing tubing and equipment shall be in good condition and adequate for the depths to be drilled and the pressures that may be encountered.

9. An accepted device shall be installed below the elevation of the lake bottom on all producing wells to prevent the escape of oil, gas, or water if the wellhead equipment is damaged.

10. No leaks or waste of oil, gas, or other liquid hydrocarbons is permitted at any time.

11. All wells must be abandoned by filling hole completely from top to bottom with cement.

12. Any pipeline under shipping lanes and anchorages must be buried. All others must be laid at or below the level of the lake bottom. Before used to transport any fluids, they must be tested with fresh water at twice the working pressure.

13. At the first show of oil or gas, drilling operations must be suspended and the casing tested and found to be free of all leaks before drilling is continued. Emergency oil saving equipment and storage must be available at all times.

14. Blowout preventers and casing control equipment to effectively control any oil, gas, or water must be maintained at all times.

15. A valve must be provided to shutoff rotary hose connections if the hose blows out.

16. No drilling is to be permitted within one mile of a public water supply or industrial water supply intake crib, intake tunnel, or pipeline, nor within 1,000 feet of any outfall structure, municipal or industrial, for the discharge to lake waters of sewage or industrial waste.

17. Wellheads are to be marked with byoys, equipped with a trawl deflector, and protected from damage by ice and boats. There is to be no interference with any fishing rights.

18. A two to eight mile zone is reserved along the shoreline which will not be offered for lease. This zone is designed to insure that Presque Isle State Park and private beaches and facilities are protected.

19. The necessary inspections will be made to insure that the lease requirements are complied with.

The first offshore well drilled in North America was in Lake Erie, opposite the Township of Romney, Ontario, during the summer of 1913. Since 1943, almost 500 offshore exploration and development wells have been drilled in Canadian waters with 225 being completed as gas wells. On the American side of the lake, oil and gas exploration has been carried out only in Pennsylvania's waters. In 1957, the Department of Forests and Waters leased two blocks comprising 35,710 acres. Two unsuccessful wells were drilled - one on each block. No pollution of the lake has occurred as a result of this drilling activity.

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POOLING COMMITTEE-LAKE ERIE
INTERNATIONAL JOINT COMMISSION
UNITED STATES AND CANADA
MINUTES OF MEETING
AUGUST 6, 1968

PURPOSE OF MEETING

The Pooling Committee consisting of representatives from the Governments of Canada, the United States, Michigan, Ohio, Pennsylvania, New York, and the Province of Ontario met at 9:30 a.m., Room 4008, General Accounting Office Building, 441 G Street, N.W., Washington, D. C., August 6, 1968.

At the meeting of the International Joint Commission at Toronto, Ontario, February 28, 1968, Pennsylvania agreed to convene a group for the purpose of studying problems related to pooling or combining contiguous oil or gas pools in separate jurisdictions.

A copy of the portion of the Minutes of that meeting pertaining to this question is enclosed for your information along with the agenda of the August 6 meeting and a list of those in attendance.

DISCUSSION

Mr. Tarr opened the meeting by stating the purpose and the discussion which followed centered on the items of the agenda. All of the problems connected with pooling in the lake were discussed by the participants along with the possibilities for developing regulations and requirements for a suitable pooling arrangement to prevent the drilling of unnecessary and uneconomic wells, prevent physical and economic waste, and to insure that each jurisdiction would receive its fair share of oil and/or gas production and/or income.

The principal topics concerning the obstacles to pooling across International Boundary discussed were:

1. Determination of the ownership of the reserves belonging to each jurisdiction in pools straddling the International Boundary. Of immediate importance would be the fixing of the International Boundary for resolving this and other pooling and drilling requirements.

2. Royalty and taxes - There would have to be a provision for the apportionment of the fair share of royalties and taxes to each jurisdiction for its acreage included in the pool.

3. Pressure differential - The effect of production from a pool being produced more rapidly on one side of the International Boundary on the production capability of the portion of the pool on the other side, as a result of severe pressure differential. Instances were cited by Mr. Byrd where this had occurred in the Mid-Continent area.

4. Differential in prices - Gas on the Canadian side of Lake Erie brings a much higher price - averaging about 45¢ per Mcf - as opposed to about 30¢ per Mcf on the United States side. With this price differential, an operator would want to produce and/or sell his gas in Canada unless the price for American gas is raised.

5. Ratable taking provision - This provision would be necessary to prohibit discrimination in favor of one producer against another in separate jurisdictions. It would obligate the buyer to purchase gas from a seller ratably with other purchases from other sellers so that each lessee and jurisdiction would be able to recover his fair share of oil and/or gas.

6. Import-Export requirements - It will be necessary to reach agreement with the Customs of both Canada and the United States regarding the export and import of gas across the International Boundary.

Mr. Sharp presented a review of Canadian operations, since all production to date in Lake Erie is located in Canadian waters under the management of the Province of Ontario. He stated that Ontario had no pooling regulations. He further pointed out the value of the gas reservoirs in the lake for storage to be utilized for peak shaving requirements.

Mr. Neil, a new drilling unit, was introduced into the lake in July by Pan American and Consummers Gas.

Mr. Sharp estimated that the rental for the piece of equipment was $5,000 per day bringing the cost of producing wells to $60,000 as opposed to the present cost of $40,000 to $45,000. Dry hole cost is estimated at $20,000-$25,000.

SUMMARY AND CONCLUSIONS

The meeting concluded with agreement that pooling could be accomplished in the lake across the separate jurisdictions.

Mr. Sharp advised that he would poll all Lake Erie operators relative to the adoption of a uniform spacing pattern of nearly 640 acres for gas and 40 acres for oil. It was felt that this spacing requirement along with limiting operations to a distance of one-half mile from the International Boundary would prevent problems across the separate jurisdictions until pooling regulations could be established.

Mr. Tarr pointed out that the Department of Forests and Waters' lease provisions included this requirement and agreed to provide copies to the committee showing that Pennsylvania, at this time, could require an equitable pooling arrangement.

It was also felt by the participants that a policy statement be formulated by the states and the Province of Ontario stating that non-unitized production would not be permitted across the International Boundary and setting forth:

(1) the limitation of production within one-half mile of the International Boundary; (2) the requirements for 640 acre gas and 40 acre oil spacing; and (3) ratable take.

The jurisdictions could withdraw from this agreement on a thirty (30) day written notice of intent. Such a policy statement could be made without enacting legislation.

It was agreed that all participants would provide their comments on the pooling problem to the Chairman by September 6. These comments would be then circulated to the committee with the Minutes of the Meeting for review prior to calling another meeting and making a report to the October Meeting of the International Joint Commission.

The comments received to date are attached as a part of the minutes of the August 6 Meeting.

Mr. Sharp has polled Lake Erie operators relative to spacing and will soon forward the results of the poll.

Also attached is a copy of the Pennsylvania Department of Forests and Waters lease for Lake Erie and maps.

Earl G. Tarr, Chairman
Mineral Economics Director
Pennsylvania Department of
Forests and Waters

POOLING COMMITTEE-LAKE ERIE
INTERNATIONAL JOINT COMMISSION
UNITED STATES AND CANADA
ATTENDANCE LIST FOR
MINUTES OF MEETING
AUGUST 6, 1968

Edward A. Albares	Federal Power Commission, Washington, D.C. 20426
Lawrence R. Alley	Executive Secretary, I.O.C.C., P. O. Box 53127, Oklahoma City, Oklahoma 73105
Richard C. Byrd	General Counsel, I.O.C.C., Ottawa, Kansas 66067
Harry A. DuPont	Regional Oil & Gas Supervisor, U.S.G.S., 19th and F Streets, N.W., Washington, D.C. 20242
Lee A. Keeling	Consultant, Philtower Building, Tulsa, Oklahoma 74103
John F. O'Leary	Chief, Bureau of Natural Gas, Federal Power Commission, Washington, D.C. 20426
Dennis A. Sharp	Supervisor, Petroleum Resources, Department of Energy and Resources Management, Toronto 5, Canada
Carl W. Sherman	Director, Division of Oil and Gas, Conservation Department, State of New York, Albany, New York 12224
Earl G. Tarr	Director, Division of Minerals, Department of Forests and Waters, Harrisburg, Pennsylvania 17120
Bruce E. Ziegler	Petroleum Engineer, Oil and Gas Division, Department of Mines and Mineral Industries, Pittsburgh, Pennsylvania 15222

POOLING COMMITTEE - LAKE ERIE
INTERNATIONAL JOINT COMMISSION
UNITED STATES AND CANADA

Meeting with representatives of the Federal
Government, States of Michigan, Ohio, Pennsylvania,
New York and Province of Ontario, Canada
9:30 A.M., Room 4008, General Accounting Office Building
441 G Street, N.W., Washington, D.C.
August 6, 1968

AGENDA

1. Purpose of Meeting - Pooling or combining Canadian and United States production from contiguous oil and gas pools.

2. Discussion of the purpose of pooling, the regulations and requirements of the several States, Province of Ontario, and the Federal Government.

3. Laws governing pooling in and across the separate jurisdictions - Conflicts States, Province of Ontario, and Federal Government.

4. Pooling requirements to be studied further to provide additional information and to determine common pooling practices for effective conservation of oil and gas in Lake Erie.

5. Arrangements for further meetings.

International Joint Commission
Minutes of Meeting
Toronto, Ontario
February 28, 1968

Pooling or combining of Canadian and United States production from contiguous oil and gas pools

28. The Meeting, after further discussion, noted that the Province of Ontario and the States intending or contemplating the institution of programmes in Lake Erie intended to prohibit drilling within one half mile of the international boundary (as well as between state boundaries) but that other features of territorial and jurisdictional limitation required further consideration and consultation.

Identification of questions, if any, requiring further study and arrangements for such study

29. The Meeting, after further discussion, agreed:

(c) that questions related to the pooling or combining of production from contiguous oil or gas pools in separate jurisdictions (para 28 above) should be considered further: Pennsylvania officials to convene a group for this purpose, with the representatives of National Energy Board and Federal Power Commission offering their assistance.

Commission Action

30. The Chairman, with the concurrence of those present:

(b) agreed to convene a meeting, similar to that just concluded, in approximately six months time to consider particularly the results of the further discussions noted in para 29 above.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF MINES AND MINERAL INDUSTRIES
HARRISBURG

OFFICE OF SECRETARY

Tidioute, Pa.
August 26, 1968

RECEIVED
AUG 3[illegible] 19[illegible]
DEPAR[illegible]
DIVISION OF [illegible]
HARRISBURG, PA.

Mr. Earl E. Tarr, Chairman
Pooling Committee-Lake Erie
408 Education Building
Harrisburg, Pa.

Dear Mr. Tarr;

After thinking over all of the discussion at our meeting in Washington, D. C. on August 6, 1968, I would like to make the following comments:

1. Due to the type of production as reported on the Canadian side of the Lake by Mr. Dennis Sharp, it appears that using the origional one mile buffer zone at present would be most pratical. (this is due to the marginal and spotty production to date)

2. With the small production to date, the royalty would not warrent the administration costs of a pooling agreement when one consideres the small amount of gas that might not be drained from between the wells on each edge of this mile strip.

3. Pooling will probably be desirable if deeper and higher pressure gas is encountered or if an oil pool extends across these boundaries.

4. I think the necessary framework should be set up where by pooling could be placed in operation quickly if the need is apparent.

5. I think the well operators should establish or suggest the actual pooling agreements and then the various govermental agencies could accept these or adjust them for more smooth operation and regulation.

Very truly yours,

Bruce E. Ziegler
Bruce E. Ziegler
Petroleum Engineer
Department of Mines and Mineral Industries
Tidioute, Penna.

cc: Hon. W. Roy Cunningham
Deputy Secretary
Oil and Gas Division

RECEIVED
AUG 19 196
DEPARTMENT OF FORESTS & WATERS
DIVISION OF MINERALS
HARRISBURG, PA.

ONTARIO
DEPARTMENT OF ENERGY AND RESOURCES MANAGEMENT

TELEPHONE
3[illegible] 1981

880 Bay Street,
Toronto 5, Ontario

	CIRC	READ
Administ[illegible]	✓	✓
P. B.		
[illegible]	✓	
A. F.		
[illegible]		
[illegible]		
F. M.		
	✓	

August 14, 1968.
Ref. No. 580.68.

To: All Lake Erie Operators

On August 6th, the Department met with representatives from the States of New York, Pennsylvania and Ohio and the National Energy Board and the Federal Power Commission to discuss pooling and unitization of Lake Erie production from contiguous oil and gas pools in separate jurisdictions.

In light of the discussions to date, this Department is giving consideration to the adoption of uniform well spacing in Lake Erie where licence of occupation boundaries so permit. The uniform spacing pattern being proposed is being based on one gas well for approximately 625 acres - one minute of Latitute by one minute of Longitude.

It has further been suggested that within each one minute of Latitude by one minute of Longitude, the first well be located in the centre of the northwest quarter of the northwest quarter (NW NW) to permit on-pattern development where subsequent well spacing is to be based on some multiple of approximately 40 acres.

The spacing of wells near the international boundary is of immediate concern to the Department and it is our intention to further discuss this matter with the above mentioned jurisdictions in early September. It is important, therefore, that the view of those Ontario operators presently holding acreage in Lake Erie be forwarded to the Department not later than August 31, 1968.

Yours very truly,

D. A. Sharp, P. Eng.,
Supervisor,
Petroleum Resources Section.

DAS/po

c.c. Mining Lands Branch
Ontario Petroleum Institute
Gas & Petroleum Assoc. of Ontario

RECEIVED
AUG 19 1968
DEPARTMENT OF FORESTS & WATERS
DIVISION OF MINERALS
HARRISBURG, PA.

INTERSTATE OIL COMPACT COMMISSION
HEADQUARTERS OFFICE: P. O. BOX 53127 • 900 N. E. 23RD STREET • OKLAHOMA CITY, OKLAHOMA 73105
TELEPHONE JAckson 5-3556 — AREA CODE 405

LAWRENCE R. ALLEY
Executive Secretary

August 15, 1968

	CIRC.	REAR
Administrative	✓	
P. R		
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[illegible]		
[illegible]		
[illegible]		
P. M		
File	✓	

Mr. Earl G. Tarr
Department of Forests and Waters
Harrisburg, Pennsylvania 17120

Dear Earl:

I again want to express my appreciation for being allowed to attend your meeting in Washington on August 6. Listening to the discussion among all of those present, it was easy to conclude that you have a very real problem, and, in my opinion, it is not going to be too easily solved.

If an arbitrary International Boundary could be established on Lake Erie, I believe the problem could be solved by an agreement between the states of the United States bordering on Lake Erie and the Province of Ontario whereby a well would not be allowed to produce that did not have the required minimum acreage. This would necessarily cause the operator to pool this spacing unit with the area in either the Province of Ontario or one of the four states of the United States. This seems to me to be a relatively simple solution; however, in listening to Mr. Dennis Sharp from Ontario, it is almost impossible to determine the International Boundary within several miles. If an arbitrary determination could be made of the International Boundary, I think this would solve the problem.

There seemed to be one or two who felt that poolwide unitization was the only solution; however, I do not think you can get compulsory unitization between lands in Lake Erie in Ontario and lands in Lake Erie in the United States without a treaty between the two countries, which would necessarily have to be approved by Congress.

Insofar as a price differential between gas in New York and gas in Ontario is concerned, I have absolutely no solution, since any movement of gas from New York State into Ontario would be under the jurisdiction of the Federal Power Commission. From listening to Mr. O'Leary, I do not think they would be too ready to raise the price of gas in New York 15 cents per thousand.

I hope this will be of some benefit to you in trying to solve what I consider an almost insolvable situation. I do not think that the present ruling of no drilling within one-half mile of the International Boundary is too helpful, since there is no International Boundary established. My recommendation would be first to see if some means could not be obtained to settle on an arbitrary International Boundary.

Again let me express my appreciation of being with you and the other members of your committee in Washington.

Kindest personal regards,

Lawrence R. Alley

LRA:mr

STATE OF NEW YORK
CONSERVATION DEPARTMENT
Division of Oil and Gas

R. STEWART KILBORNE
Commissioner
[illegible] LAWRENCE
Deputy Commissioner
LEIGHTON A. HOPE
Deputy Commissioner
ROBERT F. [illegible]
Deputy Commissioner
IRWIN H. KING
Secretary

Carl W. Sherman
Director
GI 7-5577

David F. [illegible]
Assistant Director
[illegible]

September 16, 1968

Mr. Earl Tarr
Mineral Economics Director
Division of Minerals
Department of Forests and Waters
Room 408 Education Building
Harrisburg, Pennsylvania 17120

Dear Earl:

As I stated at our meeting in Washington, D.C. on August 6, I think it is imperative that we pursue the matter of unitization across state and international boundaries.

Conservation and economic considerations make field-wide unitization a necessity. The many legal problems posed by the royalty interests being state and provincial governments and the possible importing or exporting of gas must be explored with all possible haste.

With this in mind, I would suggest that the Lake Erie Oil and Gas Committee define a theoretical field at the junction of Ontario, Pennsylvania, and New York bondaries and then proceed with the development of a unitization agreement. In this instance, I think we could also assume the roles of the working interests.

Upon completion of this document we could then ask our own attorneys to confer on what steps must be taken to ratify such an agreement and what consideration must be given to the two federal governments and their agencies. It might also be advisable to submit the same question to the Interstate Oil Compact Commission for their assistance.

I believe that we may soon be faced with these problems so I again stress the need for prompt attention. Until they are solved, I think all the states and Ontario should continue to observe the present "unofficial" agreement limiting drilling to no closer than one-half mile to the various borders.

I hope that this brief summary of my opinions on a very complex matter is sufficient for your immediate needs.

Sincerely,

Carl

Carl W. Sherman
Director
Division of Oil and Gas

CWS:ch

RECEIVED
AUG 1 1 1968
DEPARTMENT OF FORESTS & WATERS
DIVISION OF MINERALS
HARRISBURG, PA.

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

	CIRC.	READ
Administrative		✓
P. D.		
F. F.		
M. F.		
M. H.		
C. L.		
P. M.		
TARR	✓	
File		

August 9, 1968

Mr. Earl Tarr
Director, Division of Minerals
Pennsylvania Department of
Forests and Water
Harrisburg, Pennsylvania 17120

Dear Mr. Tarr:

A broad range of problems and issues were raised in our discussion of the possibilities of pooling arrangements for natural gas development on Lake Erie in the meeting held under your chairmanship on August 6. It seems to me, however, that the group arrived at the promising conclusion that pooling could be accomplished despite the difficulties imposed by multiple jurisdictions.

The most important issues that we discussed were:

1. The Basis for Establishing Participation in pooling Arrangements
   Discussion made it apparent that the problems of determining proportionate participation in pooling arrangements involving cross-border fields are little different from those involved in establishing conventional unitization of pooling agreements.

2. Ratable Takes
   It became apparent that a system for imposing ratable takes from fields or from areas of fields that lie across the international boundary is essential to the development and operation of an equitable pooling system. Participants in the discussion indicated that this requirement could be enforced through the waste provisions of the conservation statutes of their respective jurisdictions.

3. Customs Treatment
   An understanding with Customs authorities of both nations will be required to facilitate transfers and re-transfers of gas across the international boundary without hindering efficient operations of

cross-boundary fields and reservoirs.

4. Prices
   There is a recognized difference in prices paid for natural gas on the Canadian and U.S. sides of the border. This problem should be regarded as a small part of a larger and highly complex problem of price administration within the U.S. The larger problem will have to be resolved before the specific problem relative to pricing of Lake Erie produced gas can be handled.

5. Area To Be Covered in Pooling Arrangements
   It will be necessary for supervisory jurisdictions to define carefully the areas that will be included as a part of cross-border pooling arrangements. I would suggest that immediate attention be focused on those areas of cross-border fields that would be directly influenced by conservation practices of wells operating in adjacent jurisdictions. In time, agreement may be extended beyond this narrow geographical unit; however, initially it seems to me that the problems posed by attempting to obtain pooling arrangements with regard to the total area of cross-border fields are too complex to be solved without greater experience than is now available.

As a crude first attempt to outline the sort of vehicle required for achieving the above, I would suggest that all four jurisdictions adopt simultaneously a policy statement consisting of the following elements:

(1) A statement that production of natural gas within one-half mile of the international boundary would not be permitted unless pooling arrangements satisfactory to the jurisdictions involved were adopted by the leaseholders.

(2) The jurisdictional authorities stood ready to provide for uniform spacing in the cross-border producing area. This could be handled by a flat 640-acre spacing requirement or, on consultation between affected jurisdictional authorities, by a separate field order. I would suggest that the final arrangement combine both elements, requiring 640-acre spacing unless uniform field orders calling for closer spacing were issued by both jurisdictional authorities.

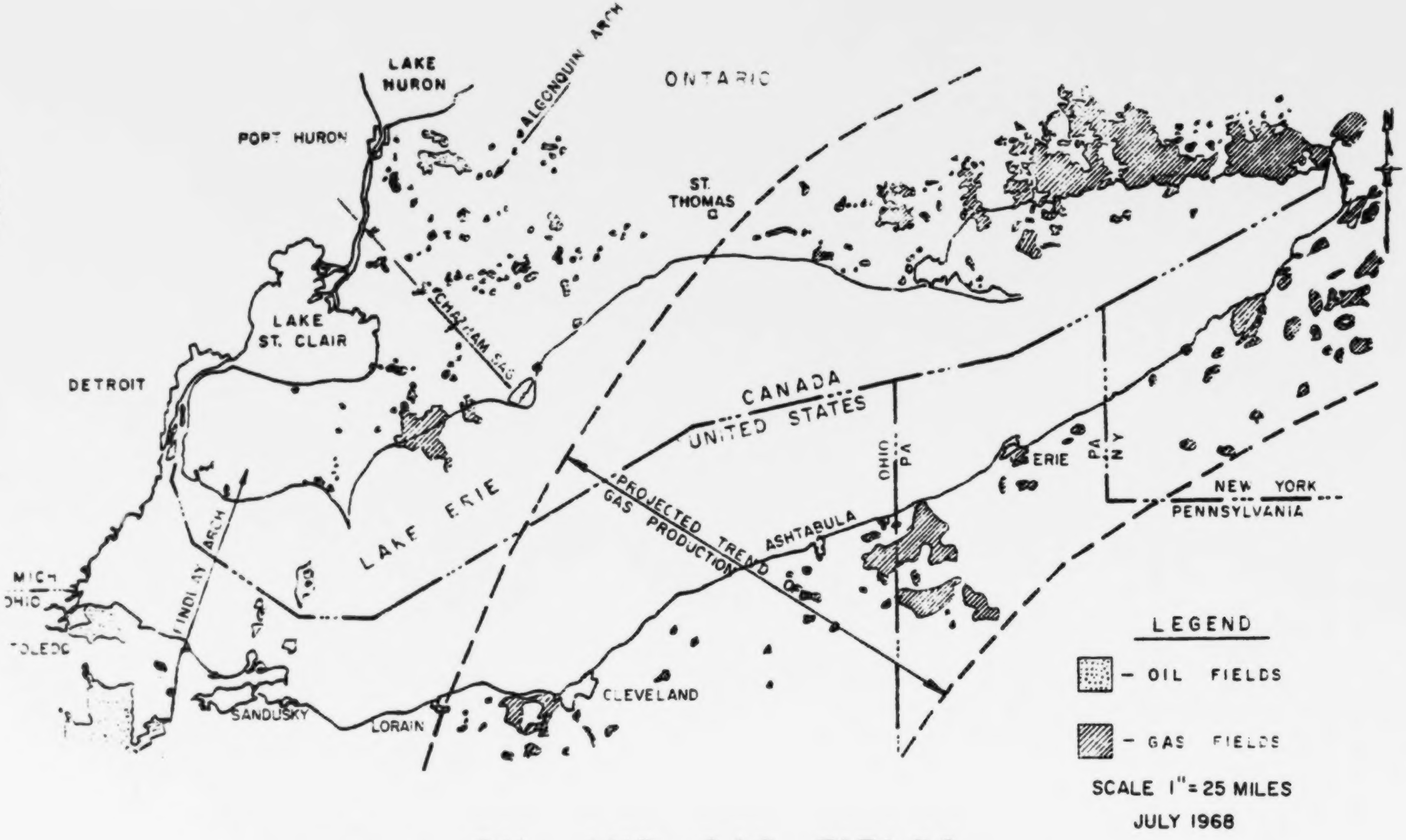
(3) The statement should make provision for nomination of allowables to determine ratable takes and for a suitable make-up period. The ratable takes provision would assure equitable treatment of all participants in the pooling arrangement and avoid wasteful producing practices.

(4) The statement should include a clause to the effect that any of the jurisdictions involved could unilaterally withdraw from the arrangement on thirty days notice to the other parties.

I think that as long as we bear in mind that the objective here is simply to achieve physically efficient operations without interference from the fact of the international border, our goal can be achieved.

Sincerely yours,

John F. O'Leary
Chief, Bureau of Natural Gas


LAKE HURON
PORT HURON
ALGONQUIN ARCH
ONTARIO
ST. THOMAS
LAKE ST. CLAIR
CHATHAM SAG
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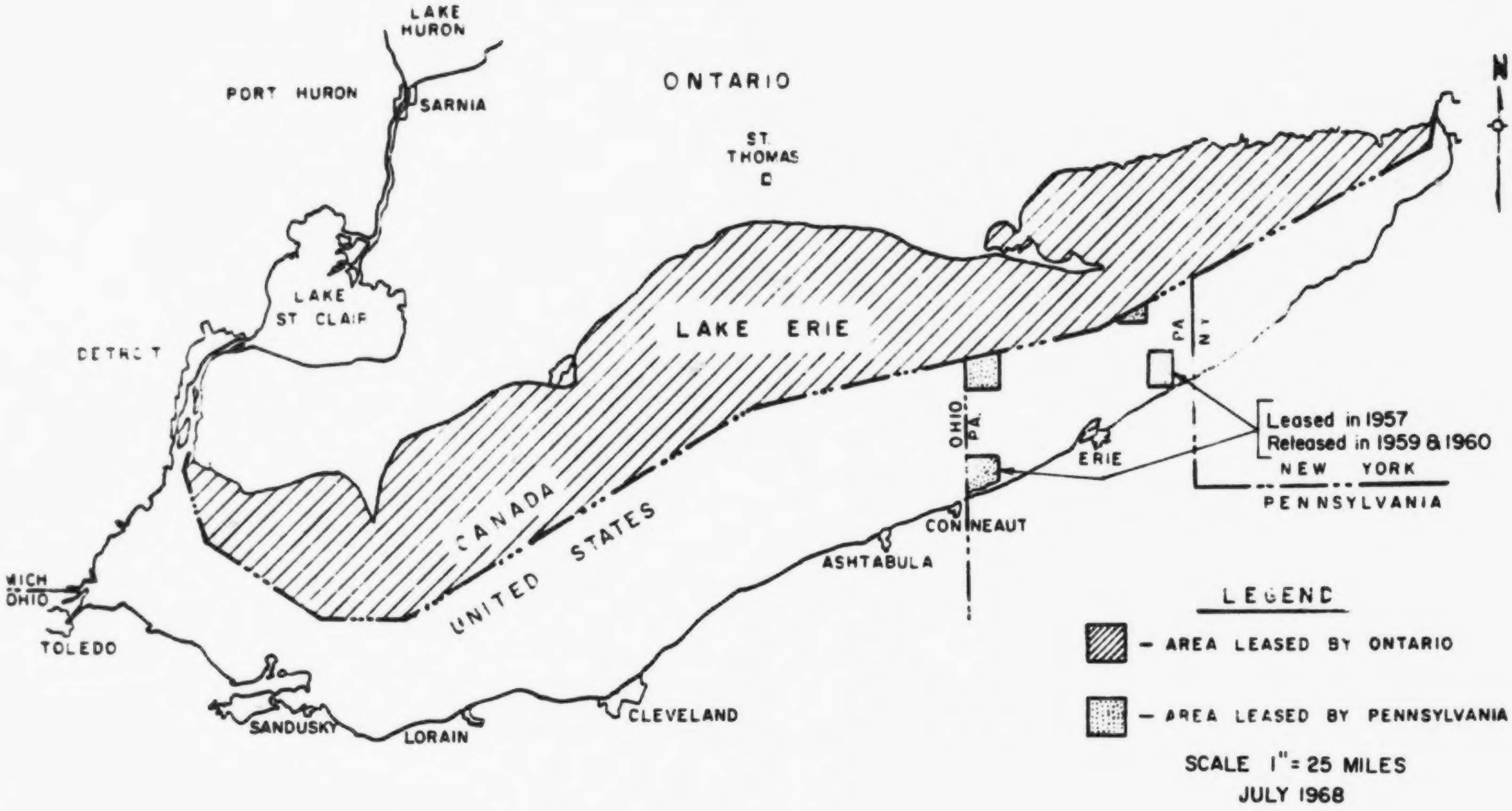
CANADA
UNITED STATES
LAKE ERIE
PROJECTED TREND GAS PRODUCTION
OHIO PA
PA NY
ERIE
NEW YORK
PENNSYLVANIA
ASHTABULA
FINDLAY ARCH
MICH
OHIO
TOLEDO
SANDUSKY
LORAIN
CLEVELAND
N
LEGEND
- OIL FIELDS
- GAS FIELDS
SCALE 1" = 25 MILES
JULY 1968

OIL AND GAS FIELDS IN AND NEAR LAKE ERIE


LAKE HURON
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TOLEDO
SANDUSKY
LORAIN
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Leased in 1957
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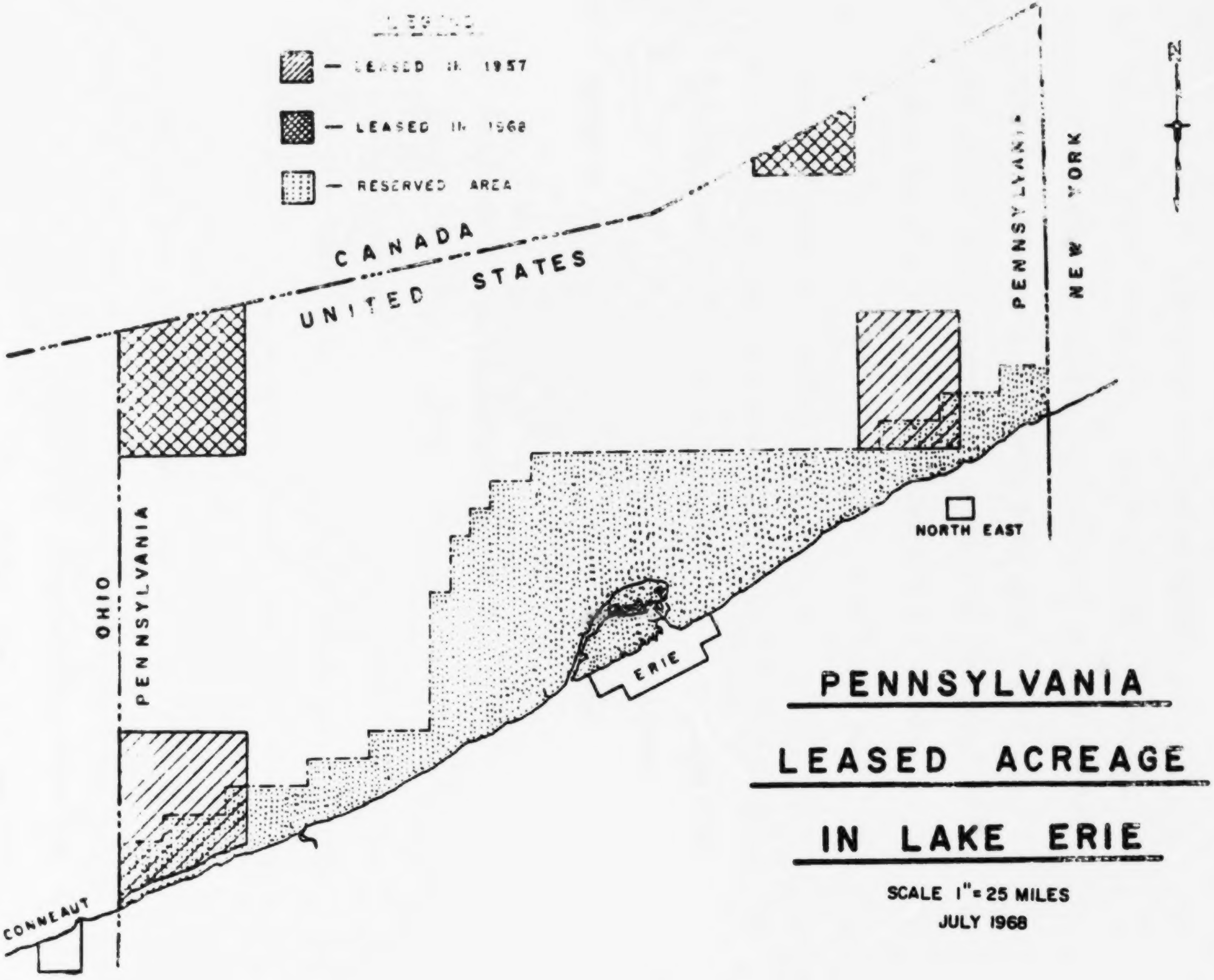
N
LEGEND
▨ - AREA LEASED BY ONTARIO
▒ - AREA LEASED BY PENNSYLVANIA
SCALE 1" = 25 MILES
JULY 1968

LEASED ACREAGE IN LAKE ERIE

FOR OIL AND GAS DRILLING


LEGEND
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N
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NORTH EAST
ERIE
OHIO
PENNSYLVANIA
CONNEAUT

PENNSYLVANIA
LEASED ACREAGE
IN LAKE ERIE

SCALE 1" = 25 MILES
JULY 1968

The least they could do would be to wait -- you have got a whole series of factors that remain to be resolved. I am not saying that this should be precluded, and that is the impact of my remarks, but until these issues can be resolved, I would expect that Pennsylvania would at least have the decency to wait.

MR. LYON: Mr. Congressman, you make it appear as if we are just beginning to drill. There has been drilling in Pennsylvania in the past. This is not a fait nouveau.

CHAIRMAN STEIN: Any further comment or question?

Well, as you and Congressman McCarthy point out, I think the issue has been joined. There are several proposals. At least from the Federal administrative level -- and maybe the Congressman could make the judgment on this -- with the interests that we are going to have in Lake Erie, specifically on the question of oil-well drilling, I would suspect that ultimately the determination is going to be made by the Congress. As you well know, Congressman McCarthy is on the particular committee and subcommittee that handles this.

Possibly the notion, as I understand it, is that if a policy is going to be made by the Congress, it may be the better part of valor and investment to wait until that policy is resolved before too much money is put into this.

The other point I think that we have administratively before our Department is just what the alternatives are for us to get into the oil-well drilling operation in Lake Erie under the present state of law. There may be two approaches: 1) to approach that through the standards-making process,and, 2) it may be possible for the Secretary to consider expanding the scope of this conference to include that specifically as a specific charge.

Now, these are all open for discussion, and I don't have any brief for any of them.

MR. LYON: Mr. Chairman, I don't think Pennsylvania would have any objection at all to include the question of oil-well drilling in this conference. But I think when you look at the public furor and attention that has been given that oil-well drilling problem in relation to the real pollution sources of this lake, the hundreds of tons of phosphates, industrial wastes and sewage and dredgings that go in this lake, frankly, we think this is a tempest in a teapot.

Lake Erie is polluted, but it is not polluted because of oil wells.

MR. McCARTHY: That may be true, but I think that was at issue here and you have touched on it as the credibility of this conference mechanism, and this is what touches the public.

Of course we know where the pollution comes from, but on one hand to be spending what we will be spending -- billions -- among the States, Federal Government, private industry, to clean up Lake Erie; and at the same time, to enter into a new program that poses the very real threat of additional pollution, the public just says, "Well, it doesn't mean anything. They aren't, obviously, serious and why should we make any efforts if they are going to go ahead -- the Government -- and they don't make often a distinction between the States and Washington -- go ahead and grant leases to start a new operation that is going to cause new pollution."

MR. LYON: Again, Congressman -- and again I think this will be the last thing I will want to say because I know we don't want to get into a continuing debate on this -- drilling for oil or gas on Lake Erie is not new; it has gone on for approximately 150 years.

CHAIRMAN STEIN: Walter, I would like to make one point -- you said one thing that I think is very important that we look at philosophically. You said that we get pollutants such as municipal, industrial wastes, dredgings, and compared to that, the oil-well operations might be a tempest in a teapot.

You know this is precisely the argument that I have heard about dredgings. Considering municipal and industrial wastes, why worry about dredging? Now, everyone can make that classification of what is important and what is not. I think the view that we have taken is that we take every pollutant no matter how large or how small and deal with it. I also believe it is a fair judgment to state that in view of the interest in the operation of all kinds of material going into Lake Erie, that unless we can work out a program -- particularly with some of the items such as dredging, and the question of oil-well drilling -- unless we can work out a program that is satisfactory to most of the people concerned and come up with a reasonable one, we have to face the very real possibility that the Congress is going to act; and they are going to tell us what the program is; and they are going to give us the guidelines to do this.

Now, this is the challenge, and I don't think there is any way out of that unless we come up with something that is going to satisfy the people in this area. They are going to petition their Congressman, and we have heard from two Congressmen this morning -- one on dredging, and one on the oil-well drilling. I am sure they are going to have sympathetic ears.

MR. LYON: Well, we would certainly be happy to work with this group or any other group on any program designed to prevent pollution from any kind of drilling. There is no question about that. We are convinced that it can be done without causing any pollution.

CHAIRMAN STEIN: Are there any other comments or questions?

Thank you very much.

MR. McCARTHY: Thank you, Mr. Chairman. I appreciate your interest and attention and the trip was worth it, based on what you have just said. Thank you. (Applause)

CHAIRMAN STEIN: Well, thank you.

MR. EAGLE: By way of introduction, again, of Mr. Simpson, I would like to point out that his firm, Havens and Emerson, have been engaged in the past couple of years, I believe, in making a very comprehensive study of Cleveland sewage and industrial waste problems, and I believe this report is just in the process of being completed now, and if Mr. Simpson can, I'd like him to give the highlights of his recommended plan for water pollution control for the city of Cleveland as he envisions it.

George Simpson

MR. SIMPSON: Ladies and gentlemen, I don't have a prepared statement this morning. I will make a few extemporaneous remarks and deal briefly with a few of the things that are contained in this rather comprehensive report.

Mayor Stokes mentioned in his address that programs for improvement of the waste treatment facilities were included in this overall Master Plan program and indeed they are. These are in keeping with the conferees' recommendations of the 1965 and subsequent meetings.

I think it is significant that more than half of the total program cost of $211,000,000 will deal with an entirely different problem and one which most large cities in this country will have to come to grips with, and that is the combined sewer problem.

We have ten or eleven small streams, the Cuyahoga River and Lake Erie, and all of these waterways are polluted by combined sewer overflows and cross-sections to a major degree. Our study found about 535 combined sewer overflows in the metropolitan Cleveland system, within the city itself, and we found over 100 cross-sections and overflows in the ostensibly separated suburban systems.

Correcting these problems or improving the combined sewer system will account for well over half of the $200,000,000 program that the Mayor mentioned.

There are about thirty to forty separate projects. They deal with all aspects of the sewer system: the streams, the treatment plants, one new treatment plant along the Cuyahoga River for handling overflow from the Kingsbury Run and oily wastes, and thirty or forty other items. I won't attempt to detail them now. The entire program, of course, will be delineated in the submission of our final report in the next few weeks.

I think that it is our feeling, having prepared this report, that pollution in the metropolitan Cleveland area has many sources. Generally, today, we have heard much about sewage treatment and this is certainly one very important source, but there are many others. There are sources from industrial wastes, and there are many sources from our sewer systems which are inadequate, antiquated, overloaded and a good deal of the money in Cleveland's program will go to correcting many of these faults.

Thank you, sir.

CHAIRMAN STEIN: Thank you. Are there any questions?

MR. EAGLE: Yes, I have a question, Mr. Stein.

George, did you attempt to set up any kind of a schedule in your report and recommendation?

MR. SIMPSON: Yes, there is a schedule that extends through 1973. The schedules that the conferees have been talking about generally are tied to pollution abatement -- that is wastewater treatment. Those schedules which you already have on the books are being met or will be met in Cleveland.

The projects going on until 1973 involve some of the sewer system improvements which weren't originally included in the conferees' recommendations or conclusions.

It is necessary, we believe, for orderly construction and financing of a program of this magnitude, to put it over perhaps a five-year period, perhaps even a little bit longer than that, in order to obtain satisfactory financing and satisfactory construction contract procedures.

MR. EAGLE: And that total cost is $211,000,000?

MR. SIMPSON: Those are, of course, projected and don't include any operating and maintenance costs, but those are projected to the year expected for construction. There are some escalations in that figure.

CHAIRMAN STEIN: This does not include stormwater drainage?

MR. SIMPSON: This includes treatment of combined sewer overflows and certain remedial measures which will deal with the combined sewer overflow problem, but it does not include complete separation.

CHAIRMAN STEIN: Are you going to treat all of your combined sewage or overflows or just the first flush?

MR. SIMPSON: We are going to treat all of it on the first flush, yes. One major phase of this is a large stabilization retention treatment basin to be constructed into Lake Erie, which was the subject of a feasibility study for the Water Pollution Control Administration. And this basin will accept all flush and runoff, including treatment plant effluent, from the Easterly Works, the polluted streams, and the combined sewer overflows of about one-third the total metropolitan area that is on the east side of Cleveland, so that there will be virtually no land runoff into Lake Erie that won't be treated in this area.

The other programs will include runoff into the harbor, and the major overflows from the west side of Cleveland will likewise be diverted for treatment and chlorination.

CHAIRMAN STEIN: Supposing you have extensive area-wide rain over a long period of time, will there come a time in your system when you are just going to bypass that and let it run out?

MR. SIMPSON: There will be some overflow because the complete separation of the system -- which incidentally this report considered -- we found that the cost of separation of Cleveland's combined sewer system would be about $948,000,000. We felt -- and I think you will agree -- that within limits of municipal financing, this is an infeasible type of expenditure. So our program really has developed around less expensive alternatives. We believe we have found them. We believe they are at least as effective.

CHAIRMAN STEIN: Oh, yes. Most of the communities in the country have come up with a plan such as this and have not gone -- at least in larger cities -- to my mind, to complete separation. As Mr. Remus indicated to you, sometimes if you go to complete separation or even if you contemplate it with all of the money, you may close the city to automobile traffic for the next twenty years and that alternative, particularly in Detroit, doesn't go.

But we faced that in Washington, D.C., and decided to go to an alternate, too; but what I am getting at -- and this is, I think, to be put before the conferees and technically the public -- is the notion that once one of these compromise systems is going to go into effect, there will be times when some of the water does go into the lake -- run into the lake -- and this should be understood, because once it goes in, some people will get emotional about this. You should know what is happening beforehand to be able to appraise the situation and to recognize that there will be times when some of the wastes will go into the lake.

The notion is that these will be infrequent and they will be of a character which will not degrade the lake too much.

MR. SIMPSON: I might say that in spite of the fact that there will be some overflow to the lake, Mr. Stein, there will be preliminary treatment, screening, and chlorination of all of the discharges into Lake Erie.

CHAIRMAN STEIN: Right. I think Mr. Poole has a question.

MR. POOLE: Mr. Simpson, have your studies proceeded to the point where you have a definite recommendation on processes for phosphate removal?

MR. SIMPSON: We have made a two-pronged recommendation. We have in the program about $650,000 to construct a 3-mgd pilot and demonstration plant at the Easterly plant for demonstrating various processes of not only phosphorus but also nitrogen removal at the Easterly plant.

The construction of phosphate removal facilities in a system as large as Cleveland's, of course, is very expensive. We feel that the city should explore all possible methods and have flow sheets before they undertake this full construction.

The second part of our recommendation, however, is that the city undertake a combined biological-chemical treatment process in the intervening period, which basically is the Barrett and Ettinger suggestion of using the existing aeration and final settling tanks for chemical precipitation, combined with biological treatment. We are recommending that the city undertake this and enter into a period when they discover whether this or some other method is the optimum for Cleveland.

A third phase is that there are recommendations on alterations to the existing wastewater treatment plants to improve biological removal. That includes greater quantities of air, so that the city is going to attack its problem we think in the way it should be attacked, that is, to discover the most advantageous and economical way of removing phosphorus. In the meanwhile, proceed on those bases which have been shown to do the job with the least capital cost.

CHAIRMAN STEIN: Are there any further comments or questions?

FROM THE FLOOR: Yes, I want --

CHAIRMAN STEIN: I am sorry. I don't think we can take any questions or comments from the audience, because if we did we would have to throw it open to everyone. You will be given an opportunity to make a statement. I ask you to hold your comments or questions until then.

I might say there is one indication here that Cleveland should be proud of, and that is John Wirts in the operation of that Easterly plant. I have heard more proposals for pilot plants or demonstration projects and research projects to be put in the Easterly plant, and I think this is a tribute to John Wirts and the way he runs that plant.

FROM THE FLOOR: May I say something there?

CHAIRMAN STEIN: I am sorry, sir.

FROM THE FLOOR: I thought it was in the paper -- it said we could talk at this meeting.

CHAIRMAN STEIN: Let me make the rules clear: Everyone will be given an opportunity to talk and talk fully. We cannot take comments from the floor for each participant. If you will hold your comments, you will be given a full opportunity to make those comments for the record. You will be heard. If we do otherwise, our experience has shown that the conferees and the rest of us will have to become semi-permanent residents of the city we go into, like Cleveland, and I know that while we like this city, all of these people are rather busy. I ask you to stay with us, to follow this procedure and I am sure that everyone will be given an opportunity to be heard and we will get all points of view on the table. No one is going to be cut off, but we are going to do this in an orderly manner.

Any other comments or questions?

MR. POSTON: I would like to ask Mr. Simpson whether or not in the study of the metropolitan area there was consideration given to the inclusion of some of the separate outlets from industry and including them in the treatment with municipal wastes.

MR. SIMPSON: Much of the industrial waste in Cleveland is now treated along with the domestic waste, Mr. Poston.

Some of the major heavy industry along the Cuyahoga River is not. Generally these have their own treatment facilities. The one example that I can give of a new industrial waste treatment that we are recommending is the construction of a treatment plant at Kingsbury Run where we will be picking up certain industrial wastes from the steel firms in that area, which are discharged into Kingsbury Run, and that will be treated. But the major industrial wastes which are now in the Cuyahoga Valley will remain treated at the industrial source, principally because the treatment plants that Cleveland has are not designed to handle that type of waste.

CHAIRMAN STEIN: Are there any other comments or questions? If not, thank you very much, sir.

I would now like to call upon Mr. Lyon for Pennsylvania. Mr. Lyon.

MR. LYON: Mr. Chairman. This report from Pennsylvania has been prepared for the purpose of updating our February 1968 status report and to provide the current status of cases in the Pennsylvania portion of the Lake Erie Basin.

The Borough of Girard is now following the revised schedule submitted on January 24, 1968. Bids have been awarded for the construction of settling and chlorination facilities. This schedule calls for compliance by June 1, 1969.

Until mid-1966, the city of Erie sewage treatment plant was removing an average of 85 per cent of the BOD with monthly averages frequently exceeding 90 per cent. From that time and through 1967, the plant has been averaging only a 75 per cent BOD reduction. The city, on May 21, 1968, submitted the final report on the pilot plant study for the joint treatment project with the Hammermill Paper Company. This report is now being reviewed and evaluated by the Pennsylvania Department of Health. The city's schedule sets the compliance date for December 15, 1970, whether or not joint treatment is carried out.

In accordance with its implementation plan for interstate waters, the Sanitary Water Board at its March 20-21, 1968, meeting, authorized the issuance of orders to sixteen municipalities with combined sewer systems serving a population greater than 30,000 (including the city of Erie) to prepare a report on the location and quantity of its combined sewer discharges and the effects of these discharges on receiving water quality. Upon receipt of orders to be issued shortly, the municipalities will be given one year to prepare and submit the report. Where the report shows that pollution occurs from such discharges, the Board will order the municipality to prepare a feasibility study for a pollution abatement program. Depending upon the size and complexity of the project, the design and construction of abatement facilities should be completed in the period 1975 to 1977. A meeting was held on May 28, 1968, with representatives of the municipalities involved to discuss the type of report to be submitted. During the meeting, a representative of the Federal Water Pollution Control Administration discussed the magnitude of the combined sewer overflow problem and the objectives of control measures.

Walter Lyon

When we reported to you last we told you that the people of Pennsylvania would have a chance to vote on a $500,000,000 bond issue. This bond issue was approved by the voters on May 16, 1967. One hundred million dollars of the $500,000,000 bond issue has been allocated under the recently passed Land and Water Conservation and Reclamation Act (Act 443) for grants to municipalities and municipal authorities for the construction, reconstruction and improvement of sewage treatment plants and major interceptors. Twenty million dollars has been made available for the two fiscal years that began on July 1, 1967, with initial funds to be available by early summer 1968. Combination State-Federal grants (P.L. 660) of at least thirty percent of the estimated eligible cost will be made in accordance with rules and regulations adopted by the Sanitary Water Board. Thus far, forty-nine projects have been certified for a combination grant, including the Borough of Girard, Erie County, which is in the order of $71,970 for sewage treatment plant additions.

I won't go into detail on our Table No. 1 in this report, which you can read at your leisure. It supplements the information in the similar table which we submitted to you in February. But, generally speaking, we need modifications and additions for the treatment plant at Erie, and it is now planned to include the remaining waste from the Hammermill Paper Company in that plant.

MODIFICATIONS OF TABLE I

SEWERAGE STATUS
(May 24, 1968)

<table>
<tr><th>Case Name</th><th>Municipality</th><th>County</th><th>Pop. Served</th><th>Receiving Stream</th><th>Adequate Trt. Fac. Provided</th></tr>
<tr><td>*Erie City</td><td>Erie City</td><td>Erie</td><td>140,000</td><td>Lake Erie</td><td>No</td></tr>
<tr><td colspan="6">Treatment modification and additions needed. Schedules for two proposals submitted, one for joint treatment with Hammermill Paper Company, the other for treatment on their separate treatment. Both include completion date of December 15, 1970.</td></tr>
<tr><td>Girard Boro</td><td>Girard Boro</td><td>Erie</td><td>2,500</td><td>Elk Creek</td><td>No</td></tr>
<tr><td colspan="6">Settling facilities modifications and chlorination needed. The Borough is following its revised schedule of January 24, 1968. Bids have been awarded for construction. Final compliance by June 1, 1969.</td></tr>
<tr><td>Larry's Truck Stop (Lawrence Boyd)</td><td>North East Twp.</td><td>Erie</td><td>360</td><td>Averill Run</td><td>No.</td></tr>
<tr><td colspan="6">Not operating treatment facilities properly, not chlorinating, high solids in effluent. The Department is taking enforcement steps.</td></tr>
</table>

*Major sewerage cases

CHAIRMAN STEIN: Have Hammermill and Erie arrived at an agreement?

MR. LYON: No, no agreement has been arrived at. The engineering report has just become available within the last few months and is now being studied by our Department.

CHAIRMAN STEIN: The difficulty I have with this -- and I don't want to belabor this -- I just want you to make the record.

MR. LYON: Sure.

CHAIRMAN STEIN: At the last meeting we had, you said that by December 31, 1967, the basic negotiations for an agreement between the city authority and Hammermill would be concluded. Now it is considerably past December 31, 1967. I would not raise this question specifically except previously in your submission -- and this is well known that your Board ordered Hammermill to provide complete treatment of industrial wastes on February 26, 1946 -- the company has been granted 10 extensions of time. The eleventh request was refused by the Board, but a schedule of compliance expiring July 31, 1966, was approved.

Even now, the question that I have to raise -- and we are not dealing with a small company without resources -- is: when are we going to get this going?

The reason I am bringing this up is that this is an anomaly in a past excellent program. They generally have as good compliance as anyone in the country -- any

State program in the country. This has been the one area that is not, and I think we should spotlight this. We have those problems, too, in our Federal regulatory program. I wouldn't raise this with you if I didn't have cases like this myself.

MR. LYON: Well, I think that both Hammermill and the State feel that the past record is not a very happy one, but I can assure you, Mr. Chairman, that we are convinced that the company is fully intending to comply with the schedule.

Now, it is true that we are two or three months behind the signing of the agrement, but this has been a matter of pilot plant studies. They had some equipment problems in completing these studies. The report has been written, and we have every reason to think that we will still be able to stay on schedule.

Everything you have said certainly is correct. We are convinced that Hammermill means business.

Girard, I mentioned earlier. Bids have been let for construction. Larry's Truck Stop unfortunately has not complied. They have the facilities they need, but they are not being operated the way they should be and we are going to get after them. I will briefly summarize some of the other waste problems.

The Hammermill Paper Company submitted the final report and the pilot plant studies on May 21, 1968. This report is now being processed and evaluated by the Pennsylvania Department of Health. The company had been disposing of its spent pulping liquors into two deep injection wells which were under permit from the Sanitary Water Board. On April 14, 1968, Well No. 1 failed and resulted in previously injected pulping wastes backflowing from the well into Lake Erie. The company immediately contacted its consultant and took prompt steps necessary to temporarily plug the well and to ultimately restore it to operation. The well was plugged and the backflow stopped on May 7, 1968.

A new application for a permit for restoration of Well No. 1 was received on May 20, 1968. The company has begun drilling a third deep well and submitted an application for a permit on May 27, 1968. A time schedule has been received which calls for restoring Well No. 1 to operation by July 1, 1968, and for placing Well No. 3 in operation by July 15, 1968. This gives us a spare well if there are ever other problems on other wells.

I think what happened at Hammermill does not give us any reason to think that this is not a good method for disposing of waste.

A new application for a Sanitary Water Board permit for additional treatment facilities at the Parker White Metal Company in Fairview Township, Erie County, is being processed and evaluated by the Pennsylvania Department of Health.

The Erie Reduction Company did not meet the April 15, 1968, compliance date in its revised schedule due to a delay in receiving approval for crossing a railroad right-of-way. All necessary approvals have now been obtained. Bids are to be received on May 27 for construction of a sewer line to connect to the city of Erie sanitary sewerage system. It is expected that this work will be completed and the discharge eliminated placing the case in compliance prior to August 1, 1968.

(See Modifications of Table II on following page.)

One new point that we would like to make, Mr. Chairman, is the need for a water quality management model. One of the least understood areas in the therapeusis of Lake Erie is the cause and effect relationship between hydrology, the inputs and outputs of degrading substances, aquatic life and biochemistry of the lake. It is essential that we establish a mathematical model which will allow us to forecast the effect of changing key variables on lake water quality. Once various sets of related levels of water quality objectives and abatement are determined, it is necessary to determine their costs so that public policy decisions can properly relate

MODIFICATIONS OF TABLE II

INDUSTRIAL WASTE STATUS
(May 24, 1968)

Case Name	Location	Type Establishment	Receiving Stream	Adequate Trt. Fac. Provided
Hammermill Paper Co.	Erie City Erie County	Integrated Pulp and Paper	Lake Erie	No

The final report on the pilot plant studies was submitted on May 21, 1968, and is now being reviewed and evaluated by the Pennsylvania Department of Health. Final compliance is to be achieved by December 15, 1970.

Parker White Metal Co.	Fairview Twp. Erie County	Metal Products	Trout Run	No

An application for additional treatment facilities is being processed and evaluated by the Pennsylvania Department of Health.

Erie Reduction	Erie City Erie County	Rendering Plant	Lake Erie	No

This case is behind schedule due to a delay in approval for sewer right-of-way. Bids to be received May 27, 1968, for connection to the City of Erie sanitary sewerage system. Compliance is expected prior to August 1, 1968.

water quality and water use improvements to dollar inputs into the program. Admittedly this is a difficult task. Our state of knowledge regarding such modeling is far behind where it should be. Nevertheless, this is probably the single most important task to which we must dedicate ourselves if Lake Erie is to be a healthy lake again.

Now, I am not trying to say here, Mr. Chairman, that we should not go ahead with the abatement program that these conferees have developed. I think we should fully implement everything we have agreed to do, but in addition I think we should do this modeling.

CHAIRMAN STEIN: How much will it cost?

MR. LYON: We estimate very roughly somewhere between $150,000 and $250,000, and this is assuming that the FWPCA would have to collect possibly some additional data for input to the model. If this is not necessary, the cost should stay around $150,000.

The lake represents a complex ecosystem. There are the hydrologic and biochemical subsystems. These, as well as others, must be mathematically related in a conceptual framework for public policymaking. While this has been done for the Delaware estuary very successfully, this has not been done for Lake Erie or any of the other Great Lakes. Understandably, the ecologic problems of lakes are much more complex than those of rivers and estuaries, but they should be subject to solution. It should be possible to develop an adaptive computer program that should give us fairly good indications of the consequences of changing certain environmental parameters in the Lake Erie ecosystem. Understandably, such a model would only give very approximate solutions and safety factors would have to be imposed if we want to attain the goals we set. But frankly we don't know today what precisely is going to be accomplished except in general we know it will be improvement by the abatement program that we have implemented. We don't know what the resulting water quality will be with the program that we have.

One other area of "treatment" has not been explored and should be. It relates to the fact that all lakes act as traps for sediments and organic and inorganic materials. They slowly fill up and by filling cause ecologic and hydrologic changes that cannot be reversed unless the trap is cleaned out by removing the trapped material. To say that this is a sizeable task is indeed an understatement. But one ought at least make an engineering feasibility study of the task of removing these sediments in order to reverse or halt the aging of the lake. The cost and consequences of doing this should be used as input to the water quality management model.

In summary, then, Pennsylvania is making good progress. We have 51 sources of waste on the lake; one of them is not moving, but they have a facility -- that is Larry's Truck Stop -- and 45 are already in compliance with the treatment requirements. The remaining five or six are on schedule or moving satisfactorily

I would like to have you meet Miss Sherry Brockway who is Miss Erie of 1966. She grew up along the shores of Lake Erie. (Applause) She is going to throw out to you some beach balls which have in them certificates that will give those who will catch them a free week-end at Erie, so that they can enjoy Presque Isle and see that our beaches are clean.

Those who have received the balloons, if you will send the certificate -- I think they have instructions on them -- you will get a free week-end including motel and other things at Erie so you can enjoy the lake, and I know it is a pleasant place because I went swimming there yesterday.

MR. METZLER: May I make a point of order here, Mr. Chairman?

CHAIRMAN STEIN: I hope it is not the one I am thinking it is.

MR. METZLER: I want to point out that they have imported a New Yorker here to represent Erie, Pennsylvania. Miss Erie is actually from Buffalo, New York.

MR. LYON: She may have grown up in Buffalo, but she lives in Erie now and she is Miss Erie, Pennsylvania, 1966.

I'd be happy to answer any questions except about Miss Brockway.

MR. POSTON: I have a question.

I wondered, Mr. Lyon, whether you gave any consideration in this model or did any investigation of what would be required in getting information from the Canadians, whether this has been part of your investigation?

MR. LYON: Being a member of the Lake Erie Pollution Advisory Board of the International Joint Commission, and knowing of the work that has been done by Ontario and the Dominion of Canada, I am confident that the Canadians would be happy to cooperate with any model that -- of course, I can't speak for them, but I get the feeling that the Canadians would be only too happy to provide us with the input that we would necessarily have to have in order to make this model of the lake complete. But I frankly think that the people of the land, in the long run, are going to have to be entitled to know specifically what their money that they are putting into pollution abatement -- both industries and the municipalities -- the money that they are putting into pollution abatement, what it will do to the lake. We don't know that today. The one thing we are sure about is that what we are doing is going to do a lot of good, but how much good we don't know, but only a model will tell us this.

CHAIRMAN STEIN: You brought one with you.

MR. LYON: The story that Lake Erie is dead is simply not true. If you read the pages of the sports magazines, you can see that Lake Erie is still a very fine lake-recreational resource. We had 3,176,000 visitors to our beaches on Presque Isle last year. Lake Erie is a "sick" lake and some of its recreational uses in other States may have been adversely affected. But Lake Erie is not "dead." It is subject to resuscitation. It is obvious that the people of Pennsylvania and the other people who live in its watershed are gearing up to spend the money that is needed to correct this problem.

The national publicity about Lake Erie being "dead," because it led people to think that the recreational uses of Lake Erie have been destroyed, cost our tourist and recreation industry in the Pennsylvania portion of the lake approximately $13 million in reduced income last year. This means that this publicity has not only deprived some sectors of our economy of this income, but more importantly has deprived many citizens of the enjoyment of the lake.

The Pennsylvania beaches at Presque Isle are a pleasant and healthy place to spend a lazy week or a week-end and we invite you and the people in the other Lake Erie States to do so.

CHAIRMAN STEIN: Any other questions or comments?

MR. METZLER: Mr. Chairman, I would like to support the concept of the model. I understood that this actually was going to be done three or four years ago. Wasn't there a start made on this?

Let me say that I am not making this facetiously or as though I had thought about it for the first time, because New York State has spent an equivalent amount of money on two of its major waterways, and I would say that neither of these waterways are anyways as near as complicated as Lake Erie. I would want to be very sure that the fact that such a modeling attempt was going to be made would not slow down the enforcement program, but I think this is entirely too complex a system for us to blithely promise that we will have 80 per cent phosphate removal, that we are going to stop the algal blooms or that with 95 per cent BOD removal we are going to return the high level of sport fishing that this lake might have enjoyed at one time.

I think that when you think of the estimates that you have already heard as to the amounts of money that are being spent by cities like Detroit and Cleveland and Buffalo, I don't see how you can justify doing this and not doing the model.

CHAIRMAN STEIN: Are there any other comments or questions on that?

MR. OEMING: It seemed to me, Mr. Chairman, that we bridged that gap when we had the original conferences, and if you will recall, I really was the one that raised serious questions about where we were going, and I thought the conferees at that time were convinced that 80 per cent removal of phosphates had been supported by the record of the conference. Now, I wonder if we are going to start all over here again reassessing this, and with its induced delays -- whether you like it or not, there are induced delays when you start new research projects.

CHAIRMAN STEIN: Well, I think that point is well made. I think our program is established on the notion that any pollution control program where we put in secondary treatment and chlorination and have phosphate removal, we know that you are going to get a significant degree of improvement.

I think what Mr. Metzler and Mr. Lyon said is: you don't have a precise degree of treatment. The one question that I have -- and I ask this in all sincerity: given the complex situation that we have in the lake, it is not like possibly an estuary or a river, or something of that kind. I am not quite so sure that once we have done the model and done the work that we will be able to make very much more of an accurate prediction than we can in the program we have. We may, but I am not sure of that.

MR. METZLER: Well, I think this is an important point, Murray. I am in the hands of the experts here, and I expect maybe Walter Lyon is better informed than I. But I am under the impression that we can get some much more precise ideas of the effects of taking out various kinds and amounts of pollutants out of the lake.

CHAIRMAN STEIN: Mr. Lyon.

MR. LYON: I would like to comment on what Mr. Oeming from Michigan said and I think Mr. Metzler touched on it, too.

I want to re-emphasize that I do not propose this model idea for a stalling device. I think we have all agreed on what has to be done. I think we should go ahead and do it, and this is not something that would make us wait and not go ahead and abate the pollution we are planning to abate. That should go right ahead; that should not be stopped. But I think that without a model -- and I would have to be the first one to admit that our knowledge in this modeling business is not as precise as we would like it to be; it is not like a Swiss watch -- but it will -- and I have talked to people who are knowledgeable in this and they agree that it will -- give us a much better guideline as to where we are going to get with this pollution abatement program and whether it is enough or whether it isn't enough. I think this is the important thing.

This is what we have got to remember: operating without a model now is almost like driving without a speedometer; you just don't know how fast you are going. You have got to sort of guess and modeling takes some of the guesswork out of some of it.

CHAIRMAN STEIN: Let me ask you a very practical question if we are going to consider this, Walter. I, and I guess at least two other conferees here, have just been through the throes of trying to get some State and Federal money together for the alewife removal program in Lake Michigan, and I know how difficult and what problems you have even dealing with relatively small amounts.

We got up $500,000 and the localities are going to put out about the same amount. You might say this was about the same size program for the State and Federal people we are getting here.

Would you propose that the money for this come as a State and Federal joint effort or would you propose that this be a federally-financed project?

MR. LYON: Frankly, I haven't thought about that particular point. I would like to recall that the modeling that was done on the Delaware was done under the Comprehensive

Planning Section of the Federal Water Pollution Act. Frankly, I don't see why that could not also be done for Lake Erie under that section of the Act.

Since you mentioned alewives, let me remind you that part of the answers coming from such a model will help us come to grips with the alewives problems. It will help us understand the ecology of this lake better so we can try to prevent the alewife problem, and this is how it will help us in every conceivable way.

CHAIRMAN STEIN: Are there other comments or questions?

If not, I think at this point we are going to plan to recess for lunch. I would like your cooperation on this: 0ne, as in all these sessions, we really don't know how many people we are going to have and how long it is going to take.

Now, I would suggest that participants other than those from the panel make arrangements with the people who are going to introduce them from their State or with myself, indicate how many want to come up, and try to give us an approximate time of the length of your statement. This will enable us to plan an efficient conference. We are trying to put this through today. Now let me see if I can meet the schedule. I think with Mr. Oeming's schedule we are just going to have to plan on pushing on through and see if we can complete this evening.

Now, I again want to assure you that everyone will be heard and heard fully. With that, we will recess until 20 after 1:00 for lunch.

(Whereupon, the Conference recessed for lunch.)

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AFTERNOON SESSION

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CHAIRMAN STEIN: Let's reconvene.

Let me read a telegram into the record:

"June 4, 1968

"Friends: Regret that I am unable to participate personally in this crucial meeting on pollution in Lake Erie. In the past months, progress has been made on this problem, but we have far to go in saving Lake Erie and in preserving this invaluable national resource for the future recreational and commercial use of millions of Americans. Most importantly, we need a firm commitment from Federal, State and local officials and from the private interests located in the area of Lake Erie that it can and will be saved. New York State, with the passage of its $1 billion 'pure waters' bond issue has taken the lead, but the Federal Government has yet to fulfill the promise implicit in the enactment of water pollution abatement legislation, in recent years. We can, however, act decisively and immediately to curb municipal and industrial pollution in the shores of the lake to stimulate the development of techniques which will save Lake Erie from eutrophication as the result of phosphates and restore the lake to its former condition, and to take such other administrative actions as will limit new sources of possible pollution. Be assured of my continuing commitment to work with you in this new and crucial conservation crusade." Signed Jacob K. Javits, U. S. Senator.

Mr. Poston.

MR. POSTON: As the Federal presentation for this conference, we have three five-minute reports: one on the compliance of the Federal installations; one on surveillance of Lake Erie; and one report on the pollution of Lake Erie beaches. We also have Col. Wright, District Engineer in charge of the pilot program on dredging, and I would like to proceed with these, starting with the report on Federal installation compliance, and Mr. Bill Riley will give this to us.

MR. RILEY: Conferees, ladies and gentlemen. My name is Bill Riley. I am here to present the statement on the status of compliance with Federal installations with the recommendations and conclusions of the Lake Erie conference.

The progress being made by Federal installations in the Lake Erie conference area toward compliance with the requirements of Executive Order 11288 and the Conference Summary has been reported at previous conference sessions. At the time of the first session of this conference in August 1965, there were approximately 390 Federal installations in the Lake Erie-Detroit River Basin. Sixteen of these had waste treatment facilities inadequate to meet the requirements later adopted by the conferees. All installations have since instituted satisfactory abatement programs with the result that all major installations, except Grosse Ile Naval Air Station, which is scheduled for deactivation by July 1969, are now in compliance with the Conference Summary. Two small installations, namely, the U.S. Coast Guard Detroit River Light Station and the Toledo Coast Guard Station, are not yet in compliance.

The status of the three installations not in compliance is as follows:

Grosse Ile Naval Air Station, Grosse Ile, Michigan: The Department of Defense, in 1964, announced plans to close Grosse Ile Naval Air Station and to transfer operations at the station to Selfridge Air Force Base. The original target date for the move was September 1967, contingent upon modification and construction of certain facilities at Selfridge. Unfavorable bids for construction of these facilities were received in May 1967. The project scope was subsequently revised and funding reprogrammed. Favorable bids were received in March 1968 for the necessary construction. The move to Selfridge Air Force Base is now scheduled for July 1969.

United States Coast Guard Detroit River Light Station, Monroe County, Michigan: Sanitary wastes from four persons are discharged without treatment to Lake Erie. Previous attempts to replace this station with an automated light structure have been unsuccessful due to ice problems. The Coast Guard has submitted a request for funds to the Congress to design and construct a permanent, unmanned and automated navigation light.

United States Coast Guard Station, Toledo, Ohio: Wastes from ten persons are discharged untreated to Maumee Bay. The Coast Guard has made arrangements to connect this station to the city of Toledo sewer system in conjunction with an adjacent yacht club. The sewer project is presently awaiting city of Toledo action.

Significant progress has been made by Federal installations since the March 22, 1967, session of this conference.

The National Aeronautics and Space Administration, Lewis Research Center, has effected maximum pollution abatement through both construction and surveillance programs. The construction of secondary treatment facilities at the Plum Brook Station, Sandusky, Ohio, was completed during February of this year. Chemical treatment facilities for the removal of phosphates have been incorporated into this plant. NASA is presently conducting tests to determine plant efficiency and practical chemical dosages for maximum phosphate removals. NASA has also instituted a complete waste discharge sampling program at its Cleveland facility. Results of this program indicate no significant pollution originating from this installation. Arrangements are now being made to routinely provide the results of this sampling program to the State Water Pollution Control agency.

The United States Coast Guard has continued their construction program and instituted a program to maintain surveillance of sewage treatment plants serving the various stations. Secondary treatment and chlorination facilities were installed at the Cleveland Coast Guard Station during July 1967. Inadequate treatment facilities aboard the Coast Guard Put-in-Bay Houseboat were replaced by an incinerator unit during April 1968.

Other installations in the conference area have been surveyed to insure adequate waste disposal practices. This surveillance will be continued. The Federal Government fully intends to keep its own house in order.

CHAIRMAN STEIN: Are there any questions?

MR. OEMING: I have a question, Mr. Chairman.

CHAIRMAN STEIN: Yes.

MR. OEMING: Mr. Chairman, I would like to ask to clarify a point here. When this gentleman reports that everybody is in compliance at least in thirteen points here, does this include phosphate removal at all these locations? Is the phosphate being removed?

MR. RILEY: No.

MR. OEMING: Well, then, actually this is not in compliance with recommendations, is it?

MR. RILEY: To that degree, no.

MR. OEMING: I wonder, Mr. Chairman, if this is the proper time to raise the question -- while this relates to Federal installations -- about operations over which Federal agencies have some control? I am referring specifically to oil pollution problems arising from shipping and particularly international shipping or interstate commerce. Is there someplace else on the program where this might be more appropriate?

CHAIRMAN STEIN: No, this might be the place, but let's try to handle the first question first on that phosphate.

MR. POSTON: The recommendations, as I understand them, on phosphate removal are rather loose

MR. OEMING: I understand that. I asked him if he was removing phosphates and he said, "No."

MR. RILEY: In one instance. In all of these installations with the exception of possibly two or three, all installations are discharging in the neighborhood of three to five thousand gallons a day -- many of these less.

MR. OEMING: My question still stands: Is phosphate being removed from any of these installations?

CHAIRMAN STEIN: One of them he said.

MR. OEMING: In one of them he says.

MR. EAGLE: Conducting tests he says.

MR. OEMING: Yes. Now, my question is -- and I think I am right -- that the conferees called for phosphate removal, not at any level but for phosphate removal. So if they are not removing phosphates, how can we say they are in compliance?

CHAIRMAN STEIN: Is there any answer on that? One of the things is -- I'd like to get a clarification on that and I think this is a major item we should consider -- the Lake Michigan conference, at which two of these States were represented, we arrived at a recommendation of a minimum of 80 percent of phosphate removal. On Lake Erie we are talking about a substantial phosphate removal. The reason for that relative lack of nonprecision is that I don't think we had as much information at that time as we did at Lake Michigan.

I think the key point is that if we are going to do as well as Lake Michigan, this is something the conferees should consider. But let's assume for the moment that we are going to ask for an 80 percent phosphate removal, how many of the Federal installations mee that?

MR. RILEY: At present?

MR. POSTON: I think that the Federal installations have secondary treatment or more, is this not right?

MR. RILEY: Right.

MR. POSTON: And insofar as phosphate removal is concerned, we do get as much phosphate removal at these plants as we would from any other municipal plant providing secondary treatment.

MR. OEMING: Oh, if that is the way you want it.

CHAIRMAN STEIN: Let me rephrase the question. I said, assuming we ask for 80 per cent phosphate removal -- I am not paraphrasing it, I am stating it again -- how many of the Federal installations will meet this at the present time?

MR. RILEY: With present treatment facilities?

CHAIRMAN STEIN: Yes.

MR. RILEY: There is only one Federal installation with new treatment facilities designed and capable of being operative to effect phosphate removal.

CHAIRMAN STEIN: Let me get this again. How many Federal installations, at the present time, are removing 80 per cent of their phosphates?

MR. RILEY: At present how many are removing phosphates?

CHAIRMAN STEIN: Yes, 80 per cent at least.

MR. RILEY: At the present, none of them are removing 80 percent of the phosphates.

CHAIRMAN STEIN: Any other comments or questions?

MR. EAGLE: Yes. I think the report is in error here, then, when you say NASA at the Lewis Research Center has effected maximum pollution abatement through both construction and surveillance programs; and then back here in Conclusion No. 7 of the Conference of 1965, we say that municipal wastes be given secondary treatment or treatment of such nature as to effectuate the maximum reduction of BOD and phosphates. So I think the report is in error.

MR. RILEY: As far as NASA is concerned --

MR. EAGLE: Tell me what kind of treatment do they have at NASA?

MR. RILEY: Originally they had a primary plant. They had a trickling filter, followed by a clari-flocculator. We had chemical precipitation facilities for phosphate removal. They are presently running jar tests to determine precisely what chemicals to use and in what dosages to get their phosphate removal. At present, their phosphates are running very low. They have the facilities. It is a matter of operation.

MR. EAGLE: Then we can accept this as the maximum treatment, then, in accordance with the conclusions as set forth?

MR. RILEY: It is part of their construction program.

CHAIRMAN STEIN: No, what percentage removal are they getting, Mr. Riley?

MR. RILEY: Excuse me?

CHAIRMAN STEIN: What per cent of phosphate removal are they getting at the NASA plant?

MR. RILEY: They haven't installed the automatic chemical feeding equipment. They have run several full plant scale tests.

CHAIRMAN STEIN: In other words -- I don't want to put words in your mouth -- in other words, you say they can, with the existing equipment, remove better than 80 per cent, but you don't know whether they are doing it all of the time now?

MR. RILEY: Well, they don't have their automated feed equipment installed yet.

CHAIRMAN STEIN: In other words, they are not getting it.

MR. RILEY: No, they are not; but they are in the process.

MR. POSTON: There was not a timetable set for phosphate removal.

CHAIRMAN STEIN: We understand that, and that is one of the major reasons we are here today, and I think this is a question that I am going to pose to the conference. We have at least a nutrient removal problem -- a pretty similar problem relating to Lake Michigan and Lake Erie. The Federal conferees and two of the States here have agreed to a minimum of 80 percent removal in Lake Michigan. We do not have this in Lake Erie. The question here is: Should we have a program at least as good as we have in Lake Michigan? Maybe we shouldn't. Maybe there are other factors in Lake Erie or maybe you don't care as much about Lake Erie, but if we do adopt that program that we have adopted in Lake Michigan for Lake Erie, no Federal installation is in compliance at the present time.

Is there anything wrong with what I just said? Are there any further comments or questions?

MR. OEMING: Did you open this up for other --

CHAIRMAN STEIN: Well, after we finish this phosphate question, I think that the phospate situation is one that we will want to grasp pretty firmly before this is over.

All right, Mr. Oeming.

MR. OEMING: Well, Mr. Chairman, my question to the conferees and to you as Chairman is: what procedure is followed in the Federal establishments to handle oil losses -- and I am referring now to repetitive oil losses --

from vessels plying the connecting channels? This means the Detroit River and Lake Erie -- and a case in point is this: Norfolk and Western which plies between Detroit and Windsor, Ontario. The ferry boat is called the Windsor.

We have suspected for some time that this is a recurring oil pollution problem, and we finally nailed it down on May 2, 1968, to a loss of oil from the storage tanks. The situation is such on this ferry that any time the oil is loaded on this ferry it has an overflow device that permits overflowing of the fuel tanks into the river.

Now, at the present time, this matter is in the hands of the Coast Guard. I am posing the question here to the conferees: if we are going to be concerned about oil -- and I think we are -- must we rely solely upon the Coast Guard or what mechanisms are we going to get to establish here to get problems like this corrected?

CHAIRMAN STEIN: Do you want to try that, Mr. Poston?

MR. POSTON: I think that the problem of oil pollution, whether it is bilge or leaky ships, is very difficult in that it is almost impossible to catch them in the act most of the time.

However, we do receive reports from various sources on such spills and we do try to follow up. Our legislation requires that we show willful discharge of oil on the part of the boat or ship if we are to obtain a conviction and this is a very difficult thing to show.

I think our Congress has under consideration legislation which would make this easier on the part of the Administration to enforce some of the regulations.

When we find out about any of these, we will proceed ourselves to investigate and get abatement and stop situations such as this, and enforce in any other manner that the law will provide.

CHAIRMAN STEIN: Well, let me ask you this question again. You have heard Mr. Deming's account of the situation there. Don't you think he has presented a prima facie case for a willful discharge?

MR. POSTON: Well, I am not sure that it is willful.

CHAIRMAN STEIN: Well, if every time that they put oil in they know there is an overflow and the overflow leaks out, what would you call it?

MR. POSTON: If he is notified I would say it is willful.

CHAIRMAN STEIN: Well, in a case like that, in a specific case like that, don't we have a procedure for getting at that?

MR. POSTON: Yes, sir.

CHAIRMAN STEIN: So I wonder -- trying that assumption -- can't we work on that case, Mr. Poston?

MR. POSTON: Yes, sir, we will proceed on this.

MR. OEMING: That is all.

MR. POSTON: Will you give us any other information relative to this particular situation?

MR. OEMING: I will hand it to you.

MR. POSTON: We will report back to you very shortly as to what actions we take.

MR. OEMING: Well, my concern, Mr. Chairman, is not that anybody is falling down here at this point, but I am looking for a mechanism that we can follow here -- some mechanism -- and if it is to be the Coast Guard, fine. But I am not so sure in my own mind whether it is to be the Coast Guard or the Federal Water Pollution Control Administration or whom.

CHAIRMAN STEIN: Well, let me try to answer that as best I understand that procedure.

You can report this to any Federal agency. Now, the Coast Guard -- and I don't know if there is a representative of the Coast Guard here -- is charged with enforcing all of the laws of the United States as they affect waters.

Now, it shouldn't really make any difference to a complainant if they report this to the Coast Guard or to us. This is an internal matter. We are supposed to have an arrangement in gathering the facts and referring a case of this type to the Department of Justice for appropriate action which would follow.

Now, without prejudging the facts -- and you know the facts in any case tend to be a little different sometimes on investigation -- but assuming a complaint comes in like this from a responsible State agency, I think this warrants an investigation. If the facts indicate that the situation is as you outline it, we do have a remedy and we do have a procedure.

Now, Mr. Poston is notified and I think we will just follow this through and get this along and follow the case through.

MR. OEMING: I am satisfied.

MR. POSTON: I didn't say that Mr. Oeming has documented the occurrence, and he has two eye witnesses, I might say. I think he has given us a very adequate report so that we may make further investigations and hopefully come up with elimination of this particular situation.

CHAIRMAN STEIN: Mr. Lyon.

MR. LYON: Mr. Chairman, this incident illustrates maybe one other important point and that is the fact that enforcement alone may not be the answer. It seems to me that we would have to institute a program, or we ought to institute a program to prevent not only oil spills but also the pumping of bilges, and so forth. Somebody has to figure out where these vessels should discharge waste materials or bilge materials. You just can't expect them not to do this if they don't have a place to put the bilge discharges. So there is a real need, in addition to enforcement activity, to develop a program that will prevent this type of thing, both on on-shore installations and on the vessels themselves.

My question basically is: Is there a Federal program that would try to come up with answers to prevent this type of thing?

MR. POSTON: I think we do not have an adequate program for coping with all of the oil pollution that comes in the lakes. I think that Congress is presently or has held hearings, and whether they come up with additional legislation that would be helpful in this area only Congress knows at this point.

We are concerned and we do follow up. I know the Coast Guard is on the scene with their watercraft in connection with other activities, and they follow up on some of these. The Corps of Engineers is interested in oil pollution, but I think that the fact that we have these spills with the frequency that we do is indicative that we do not have ample program on this in the matter of water pollution.

CHAIRMAN STEIN: Are there any other comments or questions? If not, Mr. Poston.

MR. POSTON: I would ask Mr. Harlow to give the report on surveillance of Lake Erie, as well as his report on the pollution of the Lake Erie beaches. Mr. Harlow is in charge of our Cleveland Office, and has charge of surveillance in this area and has a very active program.

MR. HARLOW: Mr. Chairman, I would like to present you with a report. If you don't have a copy, I have a few here, on the efforts of our surveillance of the lake in 1967 and 1968, and I only have three copies with me right now.

For your information, and in reading in your spare time, I have some more reports here that have compiled all of the analytical data and the physical, chemical, biological and microbiological data on the lake from the early studies at the Cleveland Program Office.

At this time, I would like to summarize our efforts in surveillance of the lake and what the water quality parameters indicate.

Between 1964 and the present, in the western basin all chemical constituents increased except chlorides, silica, and chemical oxygen demand. The total dissolved solids have increased five per cent.

In the central basin for the same period, all chemical constituents have increased except chlorides, silica, and nitrates. Dissolved solids have increased ten per cent.

In the eastern basin all chemical constitutents have increased except silica, ammonia, and nitrates. Dissolved solids increased fourteen per cent.

Silica is the only chemical to have decreased in all three basins. The average decrease is 26 per cent for the entire lake. This decrease is accompanied by increases in diatom populations -- diatoms utilizing silica in skeletal formation.

In 1967-68 the average total dissolved solids for the entire lake was 197 mg/l, an increase of nine per cent over 1963-64, whereas chlorides decreased slightly to 23 mg/l.

Sediments in 1967-68 showed increases in nutrients since 1964. Total phosphorous has increased in all basins with the greatest per cent increase occurring in the eastern basin. Ammonia increased in all basins with the largest increase again occurring in the eastern basin. Organic nitrogen increased in the western and eastern basins while decreasing slightly in the central basin. Nitrates showed decreases in the central and eastern basin sediments, while remaining constant in the western.

The west to east trend with respect to decreasing phytoplankton populations was again noted in 1967-68 data, however bloom conditions did not exist during the sampling periods.

Bacterial densities in the western basin under ice cover showed larger populations in the bottom waters, whereas non-winter 1963-64 figures showed greater populations in the top waters.

In summary, on the basis of our most recent data, the over-all water quality of Lake Erie is worse than it was in relation to the 1963-64 data. With this qualification, this conclusion should be taken with a word of caution; however, in order to make this statement a true and perfect comparison all other factors which affect water quality would have to be equal. In reality these other factors are very unequal.

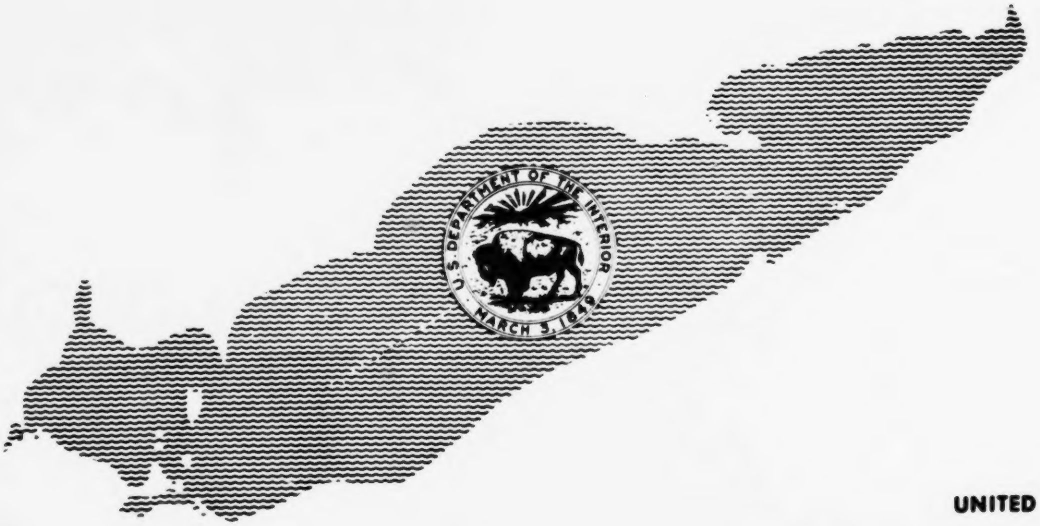
And this completes my statement on surveillance of the lake. (Report entitled "Lake Erie Surveillance Data Summary 1967-1968 follows.)

CHAIRMAN STEIN: What do you mean by "unequal"? Do you have more people there?

MR. HARLOW: Well, we have different conditions of temperature, wind, currents, waste discharges -- these other factors affect water quality as well as what is

LAKE ERIE SURVEILLANCE DATA SUMMARY

1967 - 1968



UNITED STATES
DEPARTMENT OF INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION
CLEVELAND PROGRAM OFFICE

MAY 1968

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SUMMARY

Although Lake Erie is still an excellent source of municipal raw water, the effects of pollution are becoming ever more discernible. The dissolved solids have increased by nine percent since 1964 with progressively higher concentrations from west to east. Most chemical constituents in both water and sediment have increased during the same period.

High populations of phytoplankton were noted with diatoms the overall dominant type in spring, fall, and winter, and green and blue-green in summer depending on the basin. Bloom conditions were not noted during the 1967-68 sampling period. As in 1964, the pollution-sensitive scud was all but missing in all samples. The pollution-sensitive types, such as sludgeworms and bloodworms, were in profusion.

The 1967-68 program was the first published study of the chemical, biological, and microbiological conditions under ice cover. The limited winter program revealed higher bacterial densities in western basin bottom waters as opposed to the non-winter 1963-64 findings where the highest densities were found in the surface waters.

INTRODUCTION

The following report is the first of an anticipated annual series to be prepared by the Cleveland Program Office of the Federal Water Pollution Control Administration, Great Lakes Region. All significant data gathered by the Cleveland and Detroit Program Offices in their surveillance monitoring programs on Lake Erie will be included.

The purpose of the reports is to chronicle water quality changes in Lake Erie. It is not the intent to provide detailed interpretive evaluations. However, the compiled data, along with information collected by other agencies, should be useful to those engaged in lake water resources management including pollution control.

All water quality data of a routine nature are to be entered into the STORET data processing system in use by the Federal Water Pollution Control Administration.

ACKNOWLEDGMENTS

The first four surveillance cruises conducted by the Cleveland Program Office were made with the United States Coast Guard buoy tender *Tupelo*. The cooperation of the Coast Guard is gratefully acknowledged and special thanks are given to the captain and crew of the *Tupelo* in accommodating Cleveland Program Office personnel and equipment. All waters analyzed by the Detroit Program Office were sampled with Federal Water Pollution Control Administration equipment assigned to the Detroit Office.

PROGRAM AND METHODS

The Cleveland Program Office surveillance program on Lake Erie was initiated in response to a recommendation by the state-federal Conference on Pollution in Lake Erie and its Tributaries in August 1965. The Detroit program is the result of an earlier similar conference on the Detroit River and Michigan Waters of Lake Erie in 1963. In order to better describe any changes in the overall quality of Lake Erie, both programs were primarily designed for offshore water quality definition.

The Cleveland program was established to include sample collection at thirty stations along the longitudinal midline of the lake (Figure 1). The plan called for four sampling cruises per year under the conditions of (1) ice cover, (2) spring overturn, (3) maximum temperature stratification and (4) fall overturn. Each station was to be sampled in three areas, at the surface, mid-depth, and bottom. Bottom sediment samples were also to be collected.

In accord with the Cleveland plan, midlake water and sediment were sampled in May, August, and October 1967, and January 1968. The sampling

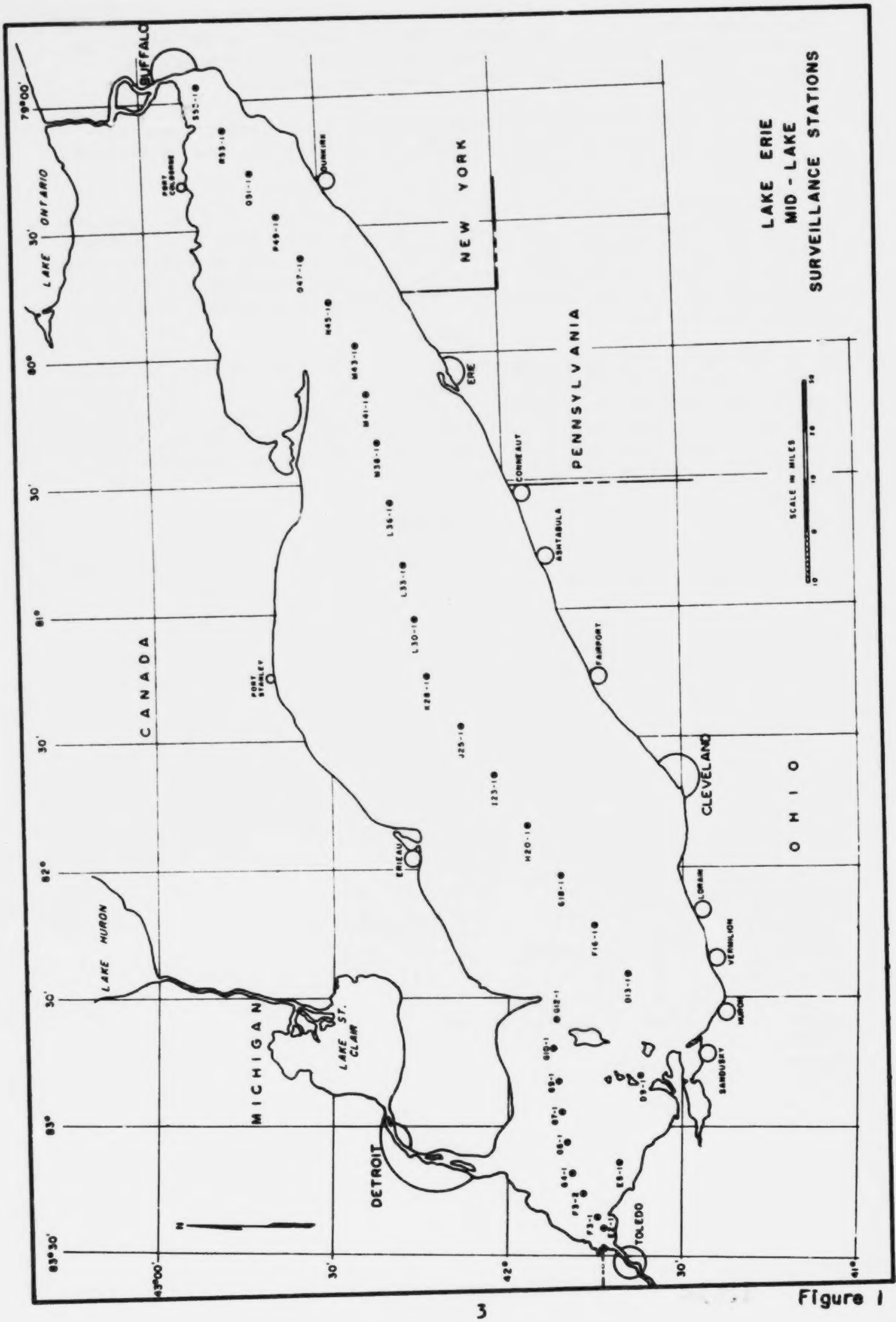
LAKE ERIE
MID - LAKE
SURVEILLANCE STATIONS
SCALE IN MILES
LAKE ONTARIO
LAKE HURON
LAKE ST. CLAIR
CANADA
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
BUFFALO
PORT COLBORNE
DUNKIRK
ERIE
CONNEAUT
ASHTABULA
FAIRPORT
CLEVELAND
LORAIN
VERMILION
HURON
SANDUSKY
TOLEDO
DETROIT
ERIEAU
PORT STANLEY
N
S55-1
R53-1
Q51-1
P49-1
O47-1
N45-1
M43-1
M41-1
M38-1
L36-1
L33-1
L30-1
K28-1
J25-1
I23-1
H20-1
G18-1
F16-1
D13-1
79°00'
30'
80°
30'
81°
30'
82°
30'
83°
83°30'
43°00'
30'
42°
30'
41°

Figure 1

was accomplished as planned except for the January cruise, which was completed only in the western basin and a portion of the central basin, then terminated because of severe ice conditions.

Only non-winter, western basin surface water samples were collected by the Detroit Program Office. Figure 2 shows the 26 stations included in the Detroit study.

In addition to cruise sampling data, future reports will include data from biweekly raw water sampling at most municipal water intakes along the south shore. The Ohio intake sampling program was initiated in March 1968 in cooperation with the Ohio Department of Health. Similar programs are anticipated with the States of Michigan, Pennsylvania, and New York.

The water quality documentation with which data from this report and future reports should be compared is compiled in the "Lake Erie Environmental Summary, 1963-64", prepared by the Cleveland Program Office, and in the "Report on Pollution of the Detroit River. Michigan Waters of Lake Erie and their Tributaries - Findings", prepared by the Detroit Program Office in 1965.

PARAMETERS

The water quality parameters shown are those which have been considered, up to this time, as most significant in Lake Erie.

Analysis of both lake water and bottom sediments is made, since each is part of a dynamic environment with continuous interchanges occurring between the two. The quality of each can and does affect the quality of the other.

The parameters included in this report are as follows:

Physical water properties

1. Temperature
2. Transparency
3. Turbidity

Water Chemistry

1. Alkalinity
2. pH
3. Conductivity
4. Dissolved solids

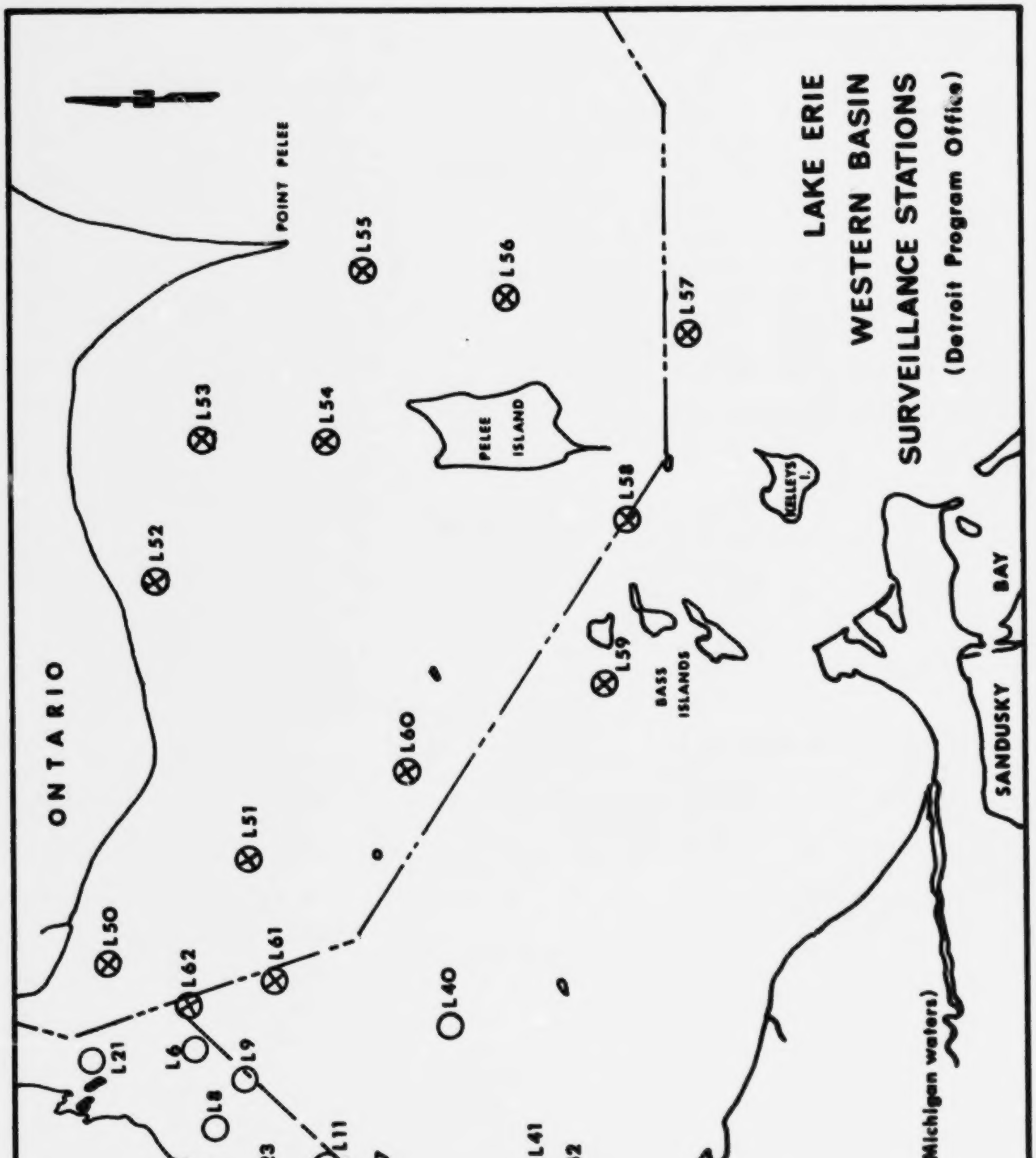
LAKE ERIE
WESTERN BASIN
SURVEILLANCE STATIONS
(Detroit Program Office)
ONTARIO
MICHIGAN
OHIO
POINT PELEE
PELEE ISLAND
KELLEYS I.
BASS ISLANDS
SANDUSKY
BAY
Maumee Bay
L50
L51
L52
L53
L54
L55
L56
L57
L58
L59
L60
L61
L62
L21
L6
L9
L8
L23
L11
L17
L14
L26
L40
L41
L42
L43
1963 and 1967 stations (Michigan waters)
1967 stations only

Figure 2

5. Total solids
6. Dissolved oxygen
7. Biochemical oxygen demand
8. Chemical oxygen demand
9. Chlorides
10. Organic nitrogen
11. Ammonia nitrogen
12. Nitrate nitrogen
13. Soluble phosphorus
14. Total phosphorus
15. Silica

Sediment Chemistry

1. pH
2. Eh
3. Biochemical oxygen demand
4. Chemical oxygen demand
5. Volatile solids
6. Total iron
7. Total phosphorus
8. Organic nitrogen
9. Ammonia nitrogen
10. Nitrate nitrogen

Water Biology

1. Plankton types and numbers
2. Organic Seston
3. Chlorophyll a and b

Sediment Biology

1. Benthic fauna types and numbers

Water Microbiology

1. Total coliform bacteria
2. Total bacteria at 20°C
3. Total bacteria at 35°C

The methods used by the Cleveland Program Office in the measurement of each of the above are given in the "Laboratory Manual, Cleveland Program Office" available from that office of the Federal Water Pollution Control Administration. The significance of each water quality parameter is detailed in "Lake Erie Environmental Summary, 1963-1964" available from the same office, and in "Physical and Chemical Quality Conditions, Lake Michigan Basin" available from the Federal Water Pollution Control Administration, Great Lakes Regional Office, Chicago, Illinois.

LIST OF ABBREVIATIONS FOR DATA COMPILATION

Abbreviations are used in this report for tabulated data according to the following list:

Units
mg/l - milligrams per liter
mg/g - milligrams per gram dry weight
µg/l - micrograms per liter
µmhos/cm - micromhos per cm
MV - millivolts

Water Chemistry
ALK or Alkal - Alkalinity in mg/l $CaCO_3$
BOD_5 - 5-day biochemical oxygen demand in mg/l
CL or Cl - chlorides in mg/l
COD - chemical oxygen demand in mg/l
CON - conductivity in µmhos/cm at 25°C
DO - dissolved oxygen in mg/l
Eh - oxidation-reduction potential in millivolts
FE or Fe - iron in mg/l
N - nitrogen
NH_3-N - ammonia nitrogen in mg/l
NO_3-N - nitrate nitrogen in mg/l
ORG-N - organic nitrogen in mg/l
P - phosphorus
pH - hydrogen ion concentration
SiO_2 - total silica
SO_4^{2}- sulfate in mg/l
SP - soluble phosphorus in mg/l
SS - suspended solids
T - temperature in degrees Centigrade
TDS - total dissolved solids in mg/l
TP - total phosphorus in mg/l
TS - total solids in mg/l
TB - turbidity in mg/l silica

Sediment Chemistry
BOD_5 - 5-day biochemical oxygen demand in mg/g, initial mixing
COD - chemical oxygen demand in mg/g
Eh - oxidation-reduction potential in millivolts
NH_3-N - ammonia nitrogen in mg/g
NO_3-N - nitrate nitrogen in mg/g
ORG-N - organic nitrogen in mg/g
pH - hydrogen ion concentration
T - temperature in degrees Centigrade
TFE - total iron in mg/g
TP - total phosphorus in mg/g
VS or vol. solids - volatile solids in % dry weight

LIST OF ABBREVIATIONS FOR DATA COMPILATION
(concluded)

Biology

Am - Amphipoda in organisms per m^2
Is - Isopoda in organisms per m^2
Pr - Prosobranchia in organisms per m^2
Pu - Pulmonata in organisms per m^2'
Hi - Hirudinea in organisms per m^2
Ol - Oligochaeta in organisms per m^2
Ne - Nematoda in organisms per m^2
Tu - Turbellaria in organisms per m^2
Un - Unionidae in organisms per m^2
Sp - Sphaeriidae in organisms per m^2
Ch - Chironomidae in organisms per m^2
Ep - Ephemeroptera in organisms per m^2
Tr - Tricoptera in organisms per m^2
Ot - Other in organisms per m^2
CHLORO - Chlorophyll in mg/m^3
No/ml - number per ml
mg/m^3 - milligrams per cubic meter
Blue-green, green, flagellates, and diatoms given in number of organisms per ml
x - Qualitative only

Microbiology

T.C. - Total coliform in organisms per 100 ml
20° SPC - Total bacterial count at 20°C in organisms per ml
35° SPC - Total bacterial count at 35°C in organisms per ml

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DISCUSSION OF ANALYTICAL DATA

The chemical, biological, and microbiological status of Lake Erie in 1967-68 will be compared with that in 1963-64, however, the reader is cautioned to consider the following.

The 1963-64 Michigan waters' stations along with several others in the western basin were the only stations reoccupied in 1967-68. All sampling at these stations was accomplished by the Detroit Program Office. The Cleveland Program Office made no attempt to reoccupy its 1963-64 stations. It was felt that midline sampling was the most efficient way to determine midlake water quality.

In addition, sampling station reproduction in the central and eastern basins can be most difficult. Although radar bearings were made where possible, many stations were located by dead reckoning. It is not inconceivable that the same station may be as much as a mile at variance with that of a former cruise. Station reproduction in the western basin is less a problem since islands and buoys are available for sighting purposes.

WATER CHEMISTRY

Upon reviewing the 1967-68 data (Tables 1 and 2) it can be concluded that with respect to chemical quality Lake Erie still is an excellent source of municipal raw water. However, upon further examination, and in comparison with historical data and the 1963-64 data collected by both the Cleveland and Detroit Program Offices, the relentless increase in most chemical concentrations can be easily detected. The 1963-64 data averages include results from some tributary-affected nearshore stations which are not included in the Cleveland Program Office 1967-68 surveys. Since these data affect the overall lake chemistry averages, the increase in chemical concentrations from 1964 to 1967 may be even more pronounced than indicated.

Cleveland Program Office data (Table 3) indicate that all chemical constituents in the western basin have increased except chloride, silica, and chemical oxygen demand. Table 4 is a comparison of chemical concentrations in the Michigan waters of Lake Erie as sampled and analyzed by the Detroit Program Office in 1967 with that in 1963. These waters, adversely affected by the Detroit River to a great extent, show increases in all chemical concentrations except chloride and organic nitrogen. Table 5 is a comparison of chemical concentrations in the western basin as determined by both Program Offices. Differences are not significant except in nitrogen data, which can be explained by seasonal variations in this parameter.

TABLE I

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
D09-01	0	5/03/67	2.0	10.2	95	--	11.2	1.3	11.7	8.2		164	167	22	0.09	1.10	0.41	.03	.05	--	0.59
D09-01	0	7/28/67	4.0	23.0	100	300	8.0	1.8	8.7	8.6	--	213	213	19	0.21	0.07	0.37	.06	.06	6	0.35
D09-01	0	10/18/67	2.0	12.7	88	272	10.3	1.7	9.3	7.6	574	169	168	19	0.15	0.09	0.15	.04	.05	10	1.20
D09-01	0																				
D09-01	22	5/03/67		9.5	90	320	10.8	1.6	12.3	8.2		140	139	20	0.05	0.68	0.37	.03	.05	--	1.20
D09-01	32	7/28/67		23.0	100	300	8.0	1.8	9.6	8.6	--	239	223	19	0.26	0.07	0.49	.05	.05	6	0.50
D09-01	23	10/18/67		12.7	87	276	10.3	1.2	6.0	7.9	556	170	153	19	0.02	0.09	0.35	.04	.05	10	0.80
D09-01																					
D09-01	42	5/03/67		9.5	95	310	10.8	1.9	11.4	8.2		162	158	20	0.12	0.74	0.33	.03	.06	--	1.40
D09-01	62	7/28/67		23.0	95	300	8.0	1.8	8.2	8.7	--	204	178	19	0.16	0.07	0.46	.05	.07	7	0.50
D09-01	42	10/18/67		12.7	89	276	10.3	1.7	4.1	7.9	550	169	160	19	0.17	0.09	0.14	.04	.05	9	0.75
D09-01																					
D13-01	0	5/02/67	11.0	7.2	100	330	12.1	0.4	8.5	8.4		--	--	--	0.12	0.22	0.11	.00	.01	--	0.51
D13-01	0	7/28/67	10.0	22.7	90	300	8.8	1.9	10.0	8.5	--	185	184	21	0.13	0.08	0.51	.02	.02	1	0.85
D13-01	0	10/18/67	6.0	13.2	97	276	10.2	1.4	5.7	7.8	532	169	163	21	0.07	0.04	0.33	.04	.04	4	0.20
D13-01	0	1/12/68	7.0	1.6		280	13.2		9.8	8.6	520			19	0.08	0.46	0.26	.02	.02	4	
D13-01	23	5/02/67		7.2	105	330	12.1	0.3	8.4	8.4		144	147	24	0.14	0.02	0.12	.00	.01	--	0.20
D13-01	36	7/28/67		21.0	90	300	8.4	0.9	8.5	8.5	--	227	227	22	0.22	0.08	0.39	.02	.02	0	0.50
D13-01	23	10/18/67		13.2	91	280	10.2	1.7	5.8	7.9	514	164	163	20	0.09	0.03	0.31	.03	.04	4	0.40
D13-01	23	1/12/68		1.5		280	13.0		7.0	8.7	508			19	0.11	0.06	0.27	.04	.04	3	
D13-01	44	5/02/67		7.0	100	330	12.2	0.8	9.4	8.4		224	233	24	0.09	0.02	0.16	.00	.01	--	0.21
D13-01	47	7/28/67		17.3	95	310	7.9	1.4	7.5	8.5	--	175	161	25	0.28	0.10	0.07	.03	.03	1	1.60
D13-01	42	10/18/67		13.1	94	284	10.2	1.6	5.3	7.9	508	169	166	21	0.24	0.03	0.12	.03	.03	4	0.25
D13-01	44	1/12/68		1.2		290	12.7		6.7	8.8	508			19	0.09	0.54	0.29	.03	.04	5	

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
E02-01	0	5/04/67	1.5	11.0	105	360		3.2	16.2	9.0		250	259	23	0.14	1.00	1.36	.04	.09	--	1.05
E02-01	0	7/26/67	1.0	23.7	80	670	8.7	3.9	19.6	7.8		213	188	20	0.65	0.01	0.50	.11	.11	11	0.45
E02-01	0	10/16/67	1.0	12.8	97	312	11.0	3.9	9.3	8.4	538	206	176	21	0.41	0.12	0.69	.07	.12		0.50
E02-01	0	1/09/68	0.3	8.8		360	12.7		18.6	8.8	478			19	0.31	2.12	0.71	.12	.14	40	
E02-01	14	5/04/67		10.9	100	360	11.7	3.3	20.0	8.8		243	243	22	0.36	0.93	0.27	.03	.08	--	1.20
E02-01	15	7/26/67		23.7	70	690	8.5	2.5	17.1	7.8		213	200	21	0.04	0.00	1.03	.10	.11		0.55
E02-01	17	10/16/67		12.5	99	312	11.0	3.8	13.0	8.4	508	264	161	21	0.52	0.13	0.58	.07	.16		0.55
E02-01																					
E02-01	26	5/04/67		11.0	105	370	10.9	3.2	20.6	8.7		236	240	21	0.27	0.95	0.49	.01	.08	--	2.50
E02-01	29	7/26/67		23.5	75	680	8.0	3.0	11.2	7.8		277	196	20	0.37	0.00	0.66	.08	.20		0.55
E02-01	29	10/16/67		12.5	108	312	10.2	4.6	24.6	8.2	538	598	176	21	0.76	0.12	0.78	.13	.29		1.95
E02-01	29	1/09/68		8.9		380	12.6			8.9	460			19	0.99	2.20	0.64	.14	.17	50	
E05-01	0	5/04/67	2.0	9.2	95	300	11.0	1.5	15.6	8.4		195	190	18	0.03	0.44	0.43	.01	.06	--	1.65
E05-01	0	7/27/67	4.0	23.0	95	270	7.2	1.9	9.4	8.5		98	88	18	0.36	0.03	0.27	.04	.06	4	1.40
E05-01	0	10/17/67	3.0	13.5	88	278	10.4	1.7	7.0	8.1	508	148	145	21	0.08	0.14	0.54	.05	.06	8	0.75
E05-01	0	1/10/68	5.0	0.6		290	13.0			8.5	490			23	0.12	0.37	0.27	.05	.05	5	
E05-01	12	5/04/67		9.2	95	300	11.1	1.3	12.5	8.6		203	192	19	0.05	0.47	0.49	.02	.06	--	1.30
E05-01	13	7/27/67		23.0	90	275	7.2	1.8	15.7	8.6		208	196	18	0.28	0.00	0.38	.03	.04	4	1.25
E05-01	12	10/17/67		13.4	87	286	10.3	1.7	5.3	7.8	490	157	141	21	0.06	0.14	0.44	.05	.05	9	0.75
E05-01	13	1/10/68		0.6		290	12.6			8.6	490			22	0.13	0.35	0.17	.05	.06	7	
E05-01	22	5/04/67		9.5	90	305	11.1	1.3	13.1	8.2		188	185	24	0.12	0.47	0.35	.02	.05	--	1.15
E05-01	24	7/27/67		23.0	95	275	7.2	1.5	8.5	8.7		204	194	18	0.18	0.04	0.45	.05	.05	3	1.30
E05-01	21	10/17/67		13.4	87	282	10.3	1.5	5.1	7.9	478	157	146	20	0.13	0.12	0.30	.04	.05	9	0.75
E05-01	23	1/10/68		0.3		290	12.4			8.7	490			23	0.12	0.36	0.23	.05	.05	5	

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
F03-01	0	5/04/67	2.0	10.0	95	300	11.6	1.9	14.4	8.4		192	190	16	0.14	0.66	0.36	.02	.05	--	1.05
F03-01	0	7/26/67	2.5	23.5	95	290	8.5	2.0	12.0	8.1	--	227	212	18	0.30	0.04	0.40	.06	.06	5	0.65
F03-01	0	10/16/67	2.0	14.0	88	286	11.2	1.9	11.0	8.3	478	163	153	20	0.36	0.09	0.41	.04	.07	10	0.50
F03-01	0	1/09/68	1.5	0.2		310	12.8			9.3	436				0.11	0.66	0.61	.05	.07	15	
F03-01	16	5/04/67		10.2	100	300	11.6	2.0	14.4	8.4		198	184	17	0.11	0.60	0.34	.02	.06	--	0.59
F03-01	17	7/26/67		23.2	90	290	8.3	2.1	13.1	8.1	--	141	116	19	0.46	0.06	0.40	.06	.07	9	0.75
F03-01	17	10/16/67		--	89	282	10.6	2.2	7.1	8.4	460	170	149	19	0.16	0.07	0.37	.05	.07	10	0.40
F03-01	16	1/09/68		0.3		300	12.6			9.4	352			22	0.11	0.64	0.36	.05	.08	15	
F03-01	30	5/04/67		10.0	95	310	11.5	1.7	13.5	8.5		193	198	17	0.07	0.62	0.38	.03	.06	--	1.05
F03-01	32	7/26/67		23.2	90	290	7.7	3.1	10.8	8.1	--	228	200	18	0.21	0.06	0.34	.06	.07	10	0.90
F03-01	29	10/16/67		13.4	89	285	11.0	1.6	8.2	8.3	496	179	158	19	0.11	0.08	0.46	.05	.08	10	0.40
F03-01	30	1/09/68		0.3		310	12.4			9.4	418			22	0.10	0.65	0.22	.04	.05	15	
F03-02	0	5/04/67	3.0	9.9	105	340	11.9	2.4	12.7	8.5		168	159	27	0.12	0.48	0.60	.03	.06	--	0.90
F03-02	0	7/27/67	3.0	23.0	95	280	7.4	2.6	10.8	7.9	--	190	161	18	0.30	0.06	0.40	.04	.05	8	1.35
F03-02	0	10/17/67	3.0	13.2	88	256	10.7	2.3	4.7	8.1	550	146	140	15	0.04	0.13	0.23	.04	.05	10	0.75
F03-02	0	1/09/68	1.8	0.5		300	13.9			8.9	496			20	0.11	0.46	0.25	.05	.06	10	
F03-02	13	5/04/67		9.9	110	360	11.4	2.4	12.6	8.6		195	204	25	0.10	0.38	0.36	.02	.05	--	1.10
F03-02	12	7/27/67		23.0	90	280	7.3	2.6	8.5	7.6	--	176	139	18	0.20	0.05	0.55	.06	.08	7	1.40
F03-02	12	10/17/67		13.2	88	248	10.5	1.8	6.9	8.2	496	152	142	16	0.04	0.13	0.35	.04	.05	10	0.80
F03-02	16	1/09/68		0.3		290	13.0			9.0	472			21	0.13	0.52	0.27	.05	.07	15	
F03-02	24	5/04/67		9.9	100	340	11.8	2.5	13.8	8.5		211	205	26	0.14	0.42	0.43	.03	.07	--	1.25
F03-02	23	7/27/67		23.0	95	285	7.2	2.2	10.0	7.7	--	158	129	18	0.39	0.05	0.36	.04	.05	8	1.45
F03-02	20	10/17/67		13.2	86	256	10.5	1.9	5.0	8.1	538	148	146	16	0.11	0.13	0.20	.04	.06	10	1.00
F03-02	29	1/09/68		0.3		300	13.2			9.1	472			21	0.14	0.63	0.16	.05	.07	15	

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
F16-01	0	5/02/67	11.0	5.4	95	320	13.2	1.0	8.1	8.3		182	173	24	0.22	0.00	0.03	.01	.01	--	0.25
F16-01	0	7/28/67	13.0	22.6	100	300	9.4	1.4	11.9	9.1	--	182	161	23	0.08	0.06	0.62	.03	.03	0	0.40
F16-01	0	10/18/67	10.0	14.0	98	320	10.0	1.3	5.2	8.3	514	181	172	27	0.10	0.00	0.33	.02	.02	2	0.35
F16-01	0	1/13/68	7.0	1.5		290	13.8			8.6	520			20	0.10	0.38	0.24	.03	.05	2	
F16-01	30	5/02/67		5.4	95	320	13.0	0.9	7.9	8.3		177	175	23	0.19	0.00	0.11	.00	.01	--	0.25
F16-01	48	7/28/67		21.2	80	310	9.0	0.7	7.5	8.9	--	206	207	24	0.05	0.02	0.53	.03	.03	0	0.35
F16-01	30	10/18/67		14.1	98	328	10.0	1.4	4.7	8.0	508	181	174	26	0.08	0.00	0.37	.03	.03	2	0.45
F16-01	31	1/13/68		0.8		290	13.6			8.7	490			21	0.11	0.39	0.24	.04	.05	3	
F16-01	59	5/02/67		5.2	90	320	12.8	0.9	8.5	8.2		173	180	23	0.07	0.00	0.21	.01	.02	--	0.50
F16-01	60	7/28/67		12.0	90	330	3.5	0.5	7.9	8.7	--	178	180	25	0.24	0.10	0.39	.02	.03	0	0.70
F16-01	56	10/18/67		14.1	98	330	10.0	1.4	5.6	8.1	496	186	182	26	0.13	0.00	0.27	.02	.02	2	0.50
F16-01	60	1/13/68		0.5		290	13.4			8.9	496			20	0.10	0.38	0.37	.04	.05	4	
G04-01	0	5/04/67	2.5	9.0	90	300	10.6	0.8	11.9	7.7		157	154	16	0.12	0.27	0.44	.03	.06	--	1.55
G04-01	0	7/27/67	4.0	22.6	85	260	9.1	1.7	8.2	8.7	--	179	182	17	0.16	0.08	0.29	.03	.04	6	0.70
G04-01	0	10/17/67	4.0	12.8	92	288	10.7	1.9	6.7	8.2	526	170	164	22	0.12	0.15	0.38	.04	.05	6	0.45
G04-01	0	1/09/68	1.0	0.3		330	12.4	1.6		8.3	478			24	0.23	0.89	0.26	.07	.11	25	
G04-01	14	5/04/67		9.0	90	280	10.6	1.2	11.9	8.0		149	153	15	0.16	0.25	0.41	.04	.06	--	1.95
G04-01	15	7/27/67		22.5	85	260	9.1	1.8	9.2	8.7	--	181	154	17	0.20	0.10	0.50	.02	.05	4	0.70
G04-01	15	10/17/67		12.8	93	292	10.8	2.5	6.5	8.2	526	170	159	22	0.15	0.16	0.25	.04	.05	5	0.45
G04-01	15	1/09/68		0.5		330	12.2	1.4		8.3	478			25	0.24	0.91	0.21	.09	.12	25	
G04-01	26	5/04/67		9.1	85	270	10.8	0.8	11.9	7.9		164	146	16	0.17	0.32	0.33	.03	.06	--	1.50
G04-01	28	7/27/67		22.5	85	255	9.0	2.3	8.7	8.7	--	158	130	17	0.41	0.10	0.00	.03	.05	4	0.80
G04-01	26	10/17/67		12.8	96	292	10.5	2.9	6.7	8.1	520	171	160	22	0.12	0.14	0.29	.04	.06	7	0.40
G04-01	26	1/09/68		0.4		330	12.1	1.5		8.4	472			24	0.24	0.93	0.34	.07	.11	25	

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
G06-01	0	5/04/67	2.0	8.4	95	250	10.8	0.4	10.8	8.5		139	110	10	0.04	0.33	0.34	.03	.04	--	1.70
G06-01	0	7/27/67	5.5	23.0	90	275	8.9	3.2	12.5	8.7	--	216	196	20	0.16	0.09	0.46	.06	.06	3	0.40
G06-01	0	10/17/67	5.0	12.9	82	236	10.5	1.4	10.1	7.5	550	139	138	14	0.07	0.18	0.17	.02	.03	5	1.30
G06-01	0	1/10/68	1.0	0.9		260	12.2		10.1	8.4	502				0.10	0.48	0.36	.06	.07	20	
G06-01	16	5/04/67		8.5	85	250	10.7	0.4	10.2	8.5		143	150	10	0.05	0.37	0.49	.02	.04	--	1.65
G06-01	27	7/27/67		23.0	90	275	8.7	1.9	10.8	8.7	--	199	184	21	0.05	0.10	0.50	.06	.07	3	0.50
G06-01	16	10/17/67		12.7	82	240	10.4	1.2	10.1	7.8	562	139	135	14	0.13	0.19	0.11	.02	.03	4	1.30
G06-01	16	1/10/68		0.8		260	12.3		9.1	8.4	484			13	0.10	0.46	0.28	.05	.08	20	
G06-01	30	5/04/67		8.5	90	250	10.9	0.5	10.2	8.5		164	161	10	0.03	0.32	0.04	.02	.04	--	1.65
G06-01	32	7/27/67		22.8	90	275	8.4	1.8	10.0	8.7	--	212	214	19	0.21	0.07	0.50	.05	.07	5	1.05
G06-01	28	10/17/67		12.8	83	240	10.4	1.5	12.0	7.5	550	137	133	14	0.05	0.17	0.29	.02	.03	6	1.20
G06-01	29	1/10/68		0.8		260	12.8		9.4	8.4	496			14	0.09	0.48	0.29	.04	.07	20	
G07-01	0	5/03/67	4.0	9.2	90	260	12.2	1.3	9.2	8.6		192	154	18	0.13	0.18	0.24	.02	.03	--	1.50
G07-01	0	7/27/67	6.0	22.7	90	250	7.9	1.2	7.5	8.6	--	199	199	16	0.08	0.07	0.36	.03	.03	3	1.20
G07-01	0	10/17/67	4.5	13.0	84	268	10.3	1.1	8.1	8.3	556	155	149	20	0.05	0.17	0.29	.02	.04	5	1.45
G07-01	0	1/10/68	1.5	1.3		310	12.4		12.0	8.4	520			23	0.20	0.71	0.37	.05	.08	20	
G07-01	25	5/03/67		8.8	85	270	11.8	0.2	9.8	8.6		192	152	17	0.07	0.26	0.38	.01	.03	--	1.55
G07-01	18	7/27/67		22.7	85	250	7.7	1.1	11.7	8.6	--	220	184	16	0.20	0.06	0.20	.03	.05	4	1.25
G07-01	17	10/17/67		12.9	83	264	10.3	1.1	8.9	8.0	550	158	146	20	0.04	0.17	0.20	.02	.02	5	1.40
G07-01	17	1/10/68		0.6		320	12.2		11.8	8.5	496			23	0.21	0.72	0.34	.08	.11	20	
G07-01	47	5/03/67		8.5	85	260	11.0	0.6	11.4	8.2		184	173	17	0.05	0.14	0.39	.01	.04	--	1.90
G07-01	34	7/27/67		22.5	85	250	7.9	1.0	7.9	8.6	--	192	189	15	0.13	0.07	0.26	.03	.04	3	1.50
G07-01	30	10/17/67		13.0	84	268	10.3	0.9	8.1	7.8	550	165	156	20	0.03	0.15	0.21	.02	.05	5	1.50
G07-01	32	1/11/68		0.5		340	11.8		13.2	8.7	508			27	0.22	0.86	0.44	.06	.13	25	

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD$_5$	COD	pH	Eh	TS	TDS	CL	NH$_3$ N	NO$_3$ N	ORG N	SP	TP	TB	SIO$_2$
G09-01	0	5/03/67	5.0	9.2	65	320	10.5	0.4	8.9	8.3		203	189	25	0.05	0.23	0.36	.03	.03	--	0.60
G09-01	0	7/27/67	6.0	22.8	85	270	7.1	0.8	7.5	8.4	--	195	189	17	0.18	0.03	0.17	.02	.02	3	1.65
G09-01	0	10/18/67	5.0	11.9	88	284	10.2	1.0	9.3	7.4	550	171	170	24	0.02	0.15	0.50	.02	.03	6	1.55
G09-01	0	1/11/68	4.0	0.2		290	12.1	0.7	8.2	8.5	532			21	0.18	0.38	0.25	.04	.07	8	
G09-01	18	5/03/67		9.2	100	310	11.0	0.6	7.4	8.1		196	192	28	0.12	0.27	0.48	.03	.03	--	0.50
G09-01	18	7/27/67		22.8	90	270	6.9	1.2	8.5	8.4	--	162	129	17	0.19	0.03	0.85	.02	.03	4	1.80
G09-01	18	10/18/67		11.9	84	292	10.2	1.3	8.1	7.6	550	175	169	25	0.09	0.15	0.38	.02	.04	6	1.60
G09-01	19	1/11/68		0.5		290	12.1	1.6	8.2	8.6	320			21	0.16	0.31	0.31	.04	.07	9	
G09-01	35	5/03/67		8.4	95	310	10.5	0.3	9.2	8.0		214	205	23	0.06	0.26	0.45	.02	.03	--	0.70
G09-01	34	7/27/67		22.8	85	260	7.1	2.1	6.9	8.5	--	178	118	17	0.18	0.03	0.35	.02	.04	6	2.15
G09-01	32	10/18/67		11.9	83	288	10.2	1.6	9.3	7.8	544	165	162	25	0.05	0.15	0.18	.02	.02	6	1.50
G09-01	35	1/11/68		0.3		290	11.8	1.5	5.1	8.7	538			21	0.16	--	0.24	.03	.07	10	
G10-01	0	5/03/67	2.0	9.2	80	290	10.6	0.9	9.2	7.6		214	192	24	0.06	0.22	0.34	.01	.04	--	0.75
G10-01	0	7/26/67	4.0	22.9	95	270	7.1	1.1	8.3	8.4	--	178	164	18	0.18	0.05	0.33	.02	.03	4	1.25
G10-01	0	10/18/67	3.0	12.6	93	268	10.2	1.7	9.7	7.4	538	169	163	19	0.07	0.15	0.33	.02	.04	7	1.35
G10-01	0	1/11/68	4.5	1.2		270	12.8		4.4	8.5	514			18	0.07	0.37	0.32	.01	.03	6	
G10-01	19	5/03/67		9.0	80	300	10.5	0.8	8.4	7.9		223	186	24	0.06	0.16	0.31	.03	.04	--	0.80
G10-01	18	7/28/67		22.8	95	270	7.1	1.2	8.4	8.5	--	182	158	19	0.21	0.05	0.27	.02	.04	3	1.20
G10-01	20	10/18/67		12.6	87	268	10.2	1.4	10.7	7.9	532	166	162	19	0.07	0.15	0.38	.02	.05	7	1.35
G10-01	19	1/11/68		1.1		270	12.6		10.1	8.6	502			19	0.05	0.36	0.33	.02	.03	6	
G10-01	36	5/03/67		8.3	90	300	10.3	0.7	9.4	7.6		224	202	23	0.08	0.13	0.56	.02	.05	--	0.90
G10-01	34	7/28/67		22.8	90	270	7.0	1.2	8.3	8.6	--	205	189	18	0.20	0.05	0.25	.02	.04	6	1.20
G10-01	36	10/18/67		12.4	90	266	10.2	1.5	10.5	8.0	526	167	153	19	0.09	0.15	0.28	.02	.04	7	1.55
G10-01	36	1/11/68		0.6		270	12.3		6.3	8.6	502			19	0.07	0.36	0.25	.02	.06	5	

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
G12-01	0	5/03/67	6.0	10.3	90	280	10.8	1.4	7.2	8.2		199	170	21	0.14	0.23	0.29	.03	.03	--	0.35
G12-01	0	7/28/67	10.0	22.5	90	265	7.6	1.0	8.7	8.5	--	186	175	21	0.17	0.04	0.33	.02	.03	2	1.05
G12-01	0	10/18/67	5.0	12.8	90	280	10.4	1.8	11.0	7.3	550	167	159	21	0.25	0.00	0.37	.02	.03	4	0.50
G12-01	0	1/12/68	4.0	1.6		280	13.2		4.9	8.6	562			22	0.05	0.32	0.24	.03	.03	4	
G12-01	21	5/03/67		9.3	85	280	10.9	1.3	7.1	8.2		199	187	21	0.13	0.24	0.44	.02	.03	--	0.45
G12-01	29	7/28/67		22.0	95	260	7.3	0.8	8.5	8.5	--	184	176	19	0.26	0.07	0.10	.01	.02	2	1.20
G12-01	20	10/18/67		12.8	91	288	10.4	1.7	10.3	7.6	532	173	162	21	0.12	0.00	0.25	.02	.04	4	0.65
G12-01	20	1/12/68		0.8		290	13.0		6.3	8.7	568			21	0.05	0.32	0.30	.02	.03	5	
G12-01	40	5/03/67		8.7	85	280	10.5	1.2	6.2	8.2		185	182	20	0.10	0.21	0.38	.02	.03	--	0.50
G12-01	40	7/28/67		22.0	100	300	3.5	1.8	8.3	8.2	--	175	174	18	0.16	0.07	0.25	.02	.02	2	1.00
G12-01	36	10/18/67		12.9	89	284	10.4	1.6	9.9	7.8	526	160	156	21	0.19	0.00	0.15	.01	.04	5	0.60
G12-01	38	1/12/68		0.7		280	12.6		5.8	8.7	550			21	0.05	0.32	0.24	.02	.03	4	
G18-01	0	5/01/67	10.0	5.0	90	320	12.7	0.1	8.1	7.7		218	205	22	0.08	0.44	0.51	.01	.02	--	0.40
G18-01	0	7/28/67	18.0	22.5	95	320	9.4	1.2	9.2	9.0	--	203	201	25	0.02	0.00	0.34	.01	.01	0	0.05
G18-01	0	10/19/67	9.0	13.5	96	320	9.9	2.1	10.5	8.1	598	184	181	24	0.06	0.02	0.34	.01	.03	3	0.40
G18-01	0	1/13/68	11.0	1.3		320	14.3	2.7	6.8	8.7	484			24	0.02	0.08	0.41	.01	.02	1	
G18-01	36	5/01/67		4.8	95	310	12.9	0.5	8.5	7.7		206	188	22	0.08	0.43	0.51	.01	.01	--	0.25
G18-01	50	7/28/67		20.0	95	320	8.6	0.7	8.7	9.0	--	193	197	26	0.07	0.00	0.21	.01	.01	0	0.10
G18-01	35	10/19/67		13.6	101	310	9.9	1.9	9.7	8.3	604	211	208	24	0.22	0.02	0.12	.01	.02	2	0.40
G18-01	36	1/13/68		1.0		330	14.3	2.6	6.3	8.8	460			24	0.02	0.08	0.31	.02	.02	1	
G18-01	71	5/01/67		4.8	90	320	12.9	0.4	8.5	7.8		198	199	22	0.12	0.42	0.47	.01	.02	--	0.25
G18-01	72	7/28/67		10.2	95	320	5.4	0.7	9.2	7.8	--	205	196	25	0.12	0.03	0.30	.01	.02	0	1.00
G18-01	68	10/19/67		13.4	100	310	9.9	1.6	8.9	8.1	610	218	215	24	0.06	0.02	0.33	.01	.01	2	0.45
G18-01	70	1/13/68		0.7		320	14.2	2.9	7.8	8.8	472			25	0.01	0.08	0.34	.01	.03	1	

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
H20-01	0	5/01/67	10.0	5.0	90	310	13.0	0.7	7.9	8.0		195	199	23	0.14	0.07	0.20	.01	.02	--	0.25
H20-01	0	7/28/67	20.0	22.5	95	310	9.6	1.4	8.9	9.1	--	195	200	25	0.04	0.00	0.30	.02	.04	0	0.10
H20-01	0	10/19/67	9.0	13.4	99	320	9.9	1.2	8.9	8.3	628	222	220	25	0.06	0.02	0.36	.01	.02	2	0.60
H20-01	0																				
H20-01	39	5/01/67		5.0	95	310	13.3	0.3	7.9	8.2		191	199	23	0.08	0.09	0.24	.01	.02	--	0.30
H20-01	54	7/28/67		19.2	95	310	8.3	0.5	8.7	9.0	--	195	181	24	0.13	0.02	0.19	.01	.01	0	0.20
H20-01	39	10/19/67		13.6	94	320	9.9	1.1	8.7	8.0	610	213	211	25	0.06	0.02	0.29	.01	.02	2	0.65
H20-01																					
H20-01	77	5/01/67		5.0	95	310	13.3	0.6	9.6	8.0		213	186	23	0.15	0.09	0.26	.01	.02	--	0.25
H20-01	79	7/28/67		10.1	105	320	5.9	0.5	8.5	8.4	--	211	190	25	0.18	0.02	0.24	.01	.01	2	0.95
H20-01	74	10/19/67		13.5	96	320	9.9	1.0	8.7	8.3	634	214	206	25	0.08	0.02	0.35	.03	.03	2	0.60
H20-01																					
123-01	0	5/01/67	10.0	4.8	95	320	13.1	0.8	8.5	8.2		194	186	22	0.16	0.20	0.29	.02	.02	--	0.35
123-01	0	7/29/67	16.0	22.2	90	300	9.0	1.3	9.8	8.9	412	194	185	23	0.16	0.05	0.42	.02	.02	0	0.25
123-01	0	10/19/67		13.4	100	320	10.0	1.2	9.1	8.3	604	217	211	24	0.07	0.02	0.38	.02	.02	2	0.55
123-01	0																				
123-01	40	5/01/67		4.7	95	310	13.2	0.5	11.7	8.3		189	183	22	0.11	0.18	0.42	.01	.02	--	0.55
123-01	57	7/29/67		19.2	95	310	7.2	0.8	7.3	8.5	490	178	185	24	0.19	0.04	0.17	.01	.01	0	0.30
123-01	40	10/19/67		13.4	96	324	9.9	1.1	8.7	8.1	622	218	215	25	0.11	0.02	0.29	.01	.02	2	0.55
123-01																					
123-01	78	5/01/67		4.5	90	310	13.1	0.7	11.4	8.2		197	182	22	0.08	0.18	0.24	.02	.02	--	0.25
123-01	80	7/29/67		10.0	95	320	6.1	0.8	7.7	8.0	490	197	190	25	0.18	0.05	0.52	.01	.01	0	0.95
123-01	76	10/19/67		13.4	100	324	9.9	1.1	9.9	8.1	610	223	221	25	0.18	0.02	0.37	.01	.02	2	0.70
123-01																					

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
J25-01	0	5/01/67	11.0	4.5	95	310	13.1	0.5	11.2	8.3		205	200	24	0.13	0.04	0.37	.01	.02	--	0.20
J25-01	0	7/29/67	15.0	22.3	90	300	9.3	1.7	9.8	8.8	382	200	178	24	0.28	0.02	0.20	.02	.02	0	0.25
J25-01	0	10/20/67	9.0	13.2	102	320	10.0	1.5	7.9	8.1	538	217	209	24	0.11	0.03	0.38	.01	.02	3	0.35
J25-01	0																				
J25-01	38	5/01/67		4.5	115	310	13.3	0.5	12.1	8.2		200	207	23	0.05	0.04	0.28	.04	.05	--	0.20
J25-01	57	7/29/67		16.1	95	320	7.9	2.2	8.1	8.4	376	198	180	25	0.10	0.00	0.38	.01	.01	0	0.30
J25-01	39	10/20/67		13.1	96	320	9.9	1.3	8.1	7.7	514	213	203	24	0.11	0.02	0.24	.01	.01	2	0.35
J25-01																					
J25-01	75	5/01/67		4.2	85	320	13.2	0.2	12.5	8.2		197	194	24	0.07	0.02	0.37	.05	.06	--	0.25
J25-01	78	7/29/67		10.5	100	300	5.2	1.6	8.7	8.0	400	292	208	25	0.16	0.04	0.35	.01	.05	3	1.30
J25-01	74	10/20/67		13.2	95	320	10.0	1.5	8.3	7.8	562	216	210	24	0.05	0.10	0.28	.01	.01	1	0.40
J25-01																					
K28-01	0	4/30/67	9.0	5.5	90	320	13.3	0.4	9.6	7.7		207	204	24	0.04	0.01	0.57	.01	.01	--	0.25
K28-01	0	7/29/67	24.0	23.3	95	310	9.2	0.8	8.5	9.0	372	182	191	24	0.05	0.00	0.36	.01	.01	0	0.10
K28-01	0	10/20/67	10.5	13.1	95	320	10.0	1.2	8.1	8.0	604	213	209	26	0.07	0.03	0.29	.01	.01	1	0.45
K28-01	0																				
K28-01	37	4/30/67		4.5	95	320	13.4	0.3	8.7	8.1		204	207	24	0.27	0.00	0.10	.02	.02	--	0.25
K28-01	57	7/29/67		20.0	95	310	8.3	0.5	6.0	8.6	364	235	196	24	0.15	0.00	0.20	.01	.01	0	0.10
K28-01	37	10/20/67		13.2	95	340	10.0	1.1	9.5	8.0	598	207	207	25	0.05	0.03	0.27	.02	.02	1	0.45
K28-01	0																				
K28-01	73	4/30/67		4.5	95	320	13.2	0.4	7.9	8.2		203	204	24	0.08	0.01	0.34	.01	.02	--	0.20
K28-01	74	7/29/67		11.0	100	320	5.2	0.7	6.5	8.0	394	203	187	25	0.07	0.04	0.52	.01	.01	0	0.70
K28-01	70	10/20/67		13.1	95	330	10.0	1.1	8.9	7.9	592	215	210	25	0.06	0.01	0.29	.02	.02	1	0.60
K28-01																					

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
L30-01	0	4/30/67	11.0	5.5	95	320	12.9	0.1	8.9	8.4		197	206	24	0.08	0.00	0.44	.01	.01	--	0.15
L30-01	0	7/29/67	24.0	23.5	90	310	9.3	1.3	6.9	8.8	358	166	161	24	0.05	0.00	0.40	.01	.01	0.1	0.10
L30-01	0	10/20/67	10.0	13.2	97	330	10.0	1.1	8.5	8.3	580	214	211	24	0.10	0.00	0.21	.01	.01	1	0.30
L30-01	0																				
L30-01	35	4/30/67		4.5	100	320	13.0	0.2	8.3	8.3		205	202	24	0.03	0.00	0.49	.02	.02	--	0.20
L30-01	56	7/29/67		21.0	95	310	8.5	0.7	6.5	8.7	372	208	211	24	0.09	0.00	0.40	.01	.01	0.2	0.10
L30-01	36	10/20/67		13.2	99	330	10.0	1.2	9.3	8.0	580	222	221	24	0.09	0.01	0.32	.01	.01	1	0.45
L30-01																					
L30-01	70	4/30/67		4.5	100	320	12.7	0.2	12.5	8.5		199	202	24	0.04	0.00	0.31	.02	.02	--	0.15
L30-01	72	7/29/67		11.0	100	320	6.0	1.2	7.5	8.4	406	230	206	24	0.12	0.04	0.38	.02	.03	1.0	0.55
L30-01	68	10/20/67		13.2	98	330	10.0	1.0	10.2	8.0	580	225	216	24	0.24	0.01	0.17	.01	.02	1	0.40
L30-01																					
L33-01	0	4/30/67	10.0	4.8	95	320	12.9	0.1	8.3	8.3		193	196	24	0.06	0.01	0.42	.01	.02	--	0.15
L33-01	0	7/29/67	20.0	23.8	95	310	9.2	1.6	8.9	8.8	358	183	185	24	0.12	0.04	0.34	.01	.01	0.2	0.15
L33-01	0	10/22/67	14.0	13.4	100	310	10.1	2.3	8.9	8.2	514	220	216	23	0.09	0.01	0.22	.02	.02	1	0.20
L33-01	0																				
L33-01	35	4/30/67		5.0	95	320	13.3	0.3	9.2	8.2		202	175	23	0.07	0.00	1.43	.01	.02	--	0.15
L33-01	52	7/29/67		21.0	95	310	7.9	1.3	6.2	8.7	358	220	179	23	0.05	0.00	0.25	.01	.01	0.2	0.20
L33-01	34	10/22/67		13.4	100	320	10.0	2.0	8.5	8.2	490	199	197	23	0.16	0.01	0.21	.02	.02	1	0.20
L33-01																					
L33-01	68	4/30/67		4.5	100	320	12.8	0.1	10.2	8.4		201	185	25	0.04	0.02	0.48	.01	.03	--	0.45
L33-01	69	7/29/67		10.9	90	320	5.2	1.1	9.6	8.5	352	196	177	24	0.11	0.06	0.29	.01	.01	0.4	0.70
L33-01	64	10/22/67		13.3	100	320	9.9	2.0	8.9	8.2	496	201	198	24	0.10	0.02	0.22	.02	.02	1	0.25
L33-01																					

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
L36-01	0	4/30/67	13.0	5.5	95	330	12.8	0.1	11.4	8.5		184	180	28	0.30	0.00	0.32	.01	.01	--	0.15
L36-01	0	7/29/67	21.0	22.9	90	310	9.5	1.4	10.2	8.7	358	204	189	24	0.06	0.00	0.29	.01	.01	0.3	0.15
L36-01	0	10/22/67	12.0	13.6	98	320	10.3	1.6	9.3	8.3	478	240	232	25	0.08	0.02	0.21	.01	.02	0.9	0.20
L36-01	0																				
L36-01	35	4/30/67		5.0	100	310	12.7	0.3	10.8	8.3		167	152	27	0.08	0.00	0.35	.02	.02	--	0.20
L36-01	53	7/29/67		22.0	90	320	9.1	0.9	8.7	8.5	358	216	204	23	0.06	0.00	0.44	.01	.01	0.2	0.15
L36-01	35	10/22/67		13.2	98	330	10.2	1.3	9.3	8.1	460	253	221	24	0.20	0.02	0.14	.01	.03	0.9	0.20
L36-01																					
L36-01	68	4/30/67		4.5	100	320	12.6	0.3	8.3	8.3		162	154	27	0.24	0.00	0.27	.02	.03	--	0.15
L36-01	67	7/29/67		16.3	90	310	7.4	1.1	7.1	7.8	376	174	176	23	0.13	0.04	0.52	.01	.01	0.3	0.35
L36-01	66	10/22/67		13.0	97	320	10.0	1.2	9.3	8.1	460	251	245	24	0.04	0.03	0.38	.01	.02	0.9	0.20
L36-01																					
M38-01	0	4/30/67	7.0	2.5	105	320	13.3	0.1	8.2	8.0		159	156	27	0.24	0.12	0.51	.01	.02	--	0.25
M38-01	0	7/30/67	20.0	22.5	95	310	9.5	1.1	8.5	8.8	352	187	160	24	0.13	0.00	0.45	.01	.01	0.2	0.15
M38-01	0	10/22/67	16.0	13.2	100	320	10.3	1.5	8.7	8.3	454	285	282	25	0.04	0.03	0.36	.01	.01	1	0.25
M38-01	0																				
M38-01	36	4/30/67		2.5	100	340	13.4	0.1	7.8	8.0		159	153	27	0.13	0.12	0.35	.02	.02	--	0.25
M38-01	54	7/30/67		21.7	95	310	9.0	0.8	7.9	8.6	352	208	203	23	0.04	0.00	0.41	.01	.01	0.2	0.15
M38-01	31	10/22/67		12.8	104	310	10.0	1.0	9.1	7.8	436	291	276	25	0.08	0.03	0.30	.01	.02	1	0.35
M38-01																					
M38-01	72	4/30/67		2.5	100	320	13.0	0.1	7.3	8.2		227	226	33	0.09	0.12	0.37	.02	.03	--	0.25
M38-01	72	7/30/67		8.0	100	330	8.2	0.8	7.1	7.5	370	232	214	24	0.09	0.10	0.38	.01	.01	0.5	0.45
M38-01	59	10/22/67		11.8	90	310	9.1	0.9	8.5	7.9	442	298	291	25	0.05	0.02	0.24	.01	.01	2	0.80
M38-01																					

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD$_5$	COD	pH	Eh	TS	TDS	CL	NH$_3$ N	NO$_3$ N	ORG N	SP	TP	TB	SIO$_2$
M41-01	0	4/30/67	12.0	2.5	96	320	13.1	0.0	8.7	7.7		157	144	20	0.05	0.11	0.52	.04	.06	--	0.15
M41-01	0	7/30/67	18.0	22.5	95	310	9.4	1.2	8.1	8.8	364	203	192	23	0.03	0.00	0.32	.01	.01	0.4	0.25
M41-01	0	10/22/67	15.0	14.0	100	320	10.3	1.4	8.9	8.3	418	243	242	25	0.12	0.02	0.18	.01	.01	1	0.30
M41-01	0																				
M41-01	58	4/30/67		2.5	100	320	13.2	0.0	7.1	7.8		143	148	27	0.15	0.12	0.37	.01	.02	--	0.15
M41-01	50	7/30/67		13.5	95	320	7.8	0.9	6.7	7.5	364	177	173	24	0.09	0.05	0.59	.01	.01	0.2	0.30
M41-01	58	10/22/67		13.6	99	320	10.1	1.0	8.5	8.1	412	255	252	24	0.20	0.02	0.21	.01	.01	0.7	0.25
M41-01																					
M41-01	114	4/30/67		2.3	100	330	13.1	0.1	8.3	7.8		150	152	27	0.05	0.11	0.36	.02	.03	--	0.15
M41-01	112	7/30/67		5.5	90	330	9.9	0.7	6.2	8.3	376	225	217	24	0.14	0.16	0.40	.02	.02	2	0.80
M41-01	112	10/22/67		8.1	103	330	6.5	0.6	9.5	7.3	418	274	257	24	0.06	0.19	0.23	.01	.02	7	1.40
M41-01																					
M43-01	0	4/30/67	11.0	2.0	95	330	13.1	0.2	6.9	8.3		152	157	27	0.07	0.16	0.40	.02	.02	--	0.15
M43-01	0	7/30/67	13.0	21.3	100	320	9.7	1.1	8.4	8.8	376	211	205	24	0.08	0.00	0.27	.01	.01	0.5	0.25
M43-01	0	10/22/67	13.0	12.4	98	320	10.7	1.7	8.3	8.2	382	244	243	24	0.12	0.04	0.22	.01	.02	0.9	0.20
M43-01	0																				
M43-01	72	4/30/67		2.0	95	320	13.3	0.4	6.2	8.3		222	220	27	0.05	0.12	0.33	.02	.02	--	0.25
M43-01	50	7/30/67		11.0	100	320	9.0	1.1	7.2	7.9	370	196	189	24	0.10	0.05	0.22	.01	.01	0.8	1.25
M43-01	110	10/22/67		11.0	98	320	9.7	0.8	10.2	7.7	394	263	241	24	0.06	0.08	0.26	.01	.01	1	0.50
M43-01																					
M43-01	142	4/30/67		2.0	100	330	13.2	0.1	8.1	8.3		223	228	27	0.03	0.12	0.51	.02	.03	--	0.20
M43-01	138	7/30/67		5.3	100	330	10.4	0.8	6.8	8.0	388	216	200	24	0.06	0.18	0.36	.02	.03	2	0.70
M43-01	136	10/22/67		6.3	100	330	7.1	0.8	9.3	7.4	394	266	256	25	0.06	0.21	0.21	.02	.02	3	1.10

TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
N45-01	0	4/29/67	11.0	2.0	95	340	13.2	0.6	7.1	8.2		211	204	27	0.05	0.10	0.38	.01	.01	--	0.15
N45-01	0	7/30/67	14.0	21.7	100	320	9.6	1.4	7.2	8.8	358	230	176	23	0.03	0.00	0.39	.01	.01	0.3	0.30
N45-01	0	10/23/67	17.0	12.5	110	320	10.1	1.4	9.3	8.7	316	302	293	25	0.11	0.03	0.19	.01	.01	0.9	0.30
N45-01	0																				
N45-01	80	4/29/67		2.0	95	340	13.1	0.8	8.1	8.2		205	191	27	0.07	0.10	0.37	.01	.02	--	0.25
N45-01	40	7/30/67		16.5	95	320	8.6	1.0	7.8	8.2	358	180	187	24	0.21	0.03	0.17	.01	.01	0.8	0.25
N45-01	120	10/23/67		9.8	113	340	8.2	0.9	7.2	8.4	322	306	303	24	0.05	0.14	0.29	.01	.03	2	0.70
N45-01																					
N45-01	160	4/29/67		2.0	95	310	13.3	0.7	8.1	8.3		209	204	28	0.02	0.06	0.58	.01	.06	--	0.25
N45-01	160	7/30/67		5.2	95	330	10.5	1.1	7.6	7.8	370	189	181	24	0.08	0.18	0.27	.02	.02	1	0.85
N45-01	154	10/23/67		6.5	105	340	7.5	1.4	7.0	8.3	322	315	297	24	0.07	0.19	0.15	.01	.03	3	1.15
N45-01																					
047-01	0	4/29/67	8.0	2.0	95	320	13.1	0.4	9.6	8.0		213	151	27	0.09	0.04	0.53	.01	.01	--	0.15
047-01	0	7/30/67	16.0	21.9	90	310	9.3	1.1	8.2	8.2	358	197	190	23	0.13	0.02	0.21	.00	.01	0.2	0.25
047-01	0	10/23/67	18.0	13.0	100	310	10.1	1.2	9.5	9.5	448	240	235	25	0.07	0.03	0.18	.01	.02	0.6	0.20
047-01	0																				
047-01	79	4/29/67		2.0	95	320	13.1	0.7	6.7	8.2		190	178	26	0.03	0.09	0.37	.01	.02	--	0.20
047-01	55	7/30/67		18.2	90	320	8.2	0.9	6.6	7.4	370	193	197	24	0.08	0.00	0.40	.01	.01	0.1	0.25
047-01	130	10/23/67		10.8	100	320	4.0	0.8	8.1	7.9	442	269	256	24	0.06	0.08	0.25	.00	.01	2	0.65
047-01																					
047-01	157	4/29/67		2.0	95	320	13.3	0.3	6.9	8.1		231	180	27	0.08	0.11	0.39	.01	.02	--	0.45
047-01	175	7/30/67		5.2	95	320	10.6	0.8	5.6	7.0	394	202	193	25	0.16	0.19	0.14	.01	.02	1.0	0.50
047-01	177	10/23/67		7.1	99	320	7.5	0.6	7.6	7.7	442	280	267	23	0.17	0.19	0.19	.02	.02	6	1 20
047-01																					

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TABLE I (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD$_5$	COD	pH	Eh	TS	TDS	CL	NH$_3$ N	NO$_3$ N	ORG N	SP	TP	TB	SIO$_2$
P49-01	0	4/29/67	8.0	3.2	95	330	13.3	1.1	8.5	8.6		229	189	27	0.04	0.09	0.47	.01	.02	--	0.20
P49-01	0	7/30/67	20.0	21.5	95	310	9.2	1.0	6.4	9.0	388	212	208	24	0.06	0.01	0.25	.01	.01	0.2	0.25
P49-01	0	10/23/67	12.0	13.6	99	310	10.3	1.2	8.5	8.2	430	244	243	24	0.08	0.01	0.23	.01	.02	1	0.25
P49-01	0																				
P49-01	49	4/29/67		3.2	95	320	13.1	1.2	8.7	8.2		233	180	27	0.05	0.07	0.46	.01	.02	--	0.20
P49-01	60	7/30/67		19.5	95	310	8.5	0.5	6.0	8.7	376	211	197	24	0.08	0.00	0.25	.01	.01	0.1	0.25
P49-01	48	10/23/67		13.4	97	320	10.2	1.0	10.3	8.2	418	262	257	24	0.04	0.00	0.36	.00	.02	1	0.35
P49-01																					
P49-01	96	4/29/67		3.2	95	320	13.4	1.1	12.9	8.4		238	222	27	0.04	0.00	0.65	.02	.05	--	0.65
P49-01	99	7/30/67		6.0	100	330	6.8	0.4	7.8	8.0	382	215	204	25	0.13	0.15	0.30	.03	.04	1.0	0.85
P49-01	92	10/23/67		13.2	98	320	10.0	0.9	8.3	8.1	412	216	210	25	0.05	0.00	0.30	.03	.02	4	0.35
P49-01																					
Q51-01	0	4/29/67	6.0	3.5	90	320	13.0	1.1	10.7	7.9		217	222	28	0.15	0.08	0.33	.01	.03	--	0.20
Q51-01	0	7/30/67	18.0	21.1	100	320	9.2	1.0	6.6	8.8	370	210	211	25	0.05	0.00	0.34	.01	.01	0.1	0.15
Q51-01	0	10/23/67	10.5	14.2	101	320	10.3	1.0	8.5	8.2	406	215	214	25	0.05	0.02	0.27	.01	.01	2	0.35
Q51-01	0																				
Q51-01	37	4/29/67		3.5	90	320	13.0	1.1	10.7	7.9		214	218	27	0.06	0.06	0.55	.02	.02	--	0.20
Q51-01	64	7/30/67		18.8	95	320	8.2	0.6	7.0	8.7	370	214	192	25	0.08	0.00	0.21	.00	.01	0.1	0.25
Q51-01	36	10/23/67		13.6	99	320	10.2	1.0	8.5	8.1	400	216	207	25	0.08	0.00	0.34	.01	.02	2	0.25
Q51-01																					
Q51-01	72	4/29/67		3.5	95	320	13.0	1.5	11.7	7.9		241	205	28	0.06	0.04	0.77	.02	.03	--	0.25
Q51-01	74	7/30/67		13.1	95	320	6.2	0.7	6.0	7.9	400	225	185	25	0.15	0.10	0.30	.01	.01	0.2	0.75
Q51-01	69	10/23/67		13.4	101	320	10.2	1.4	8.1	8.2	400	204	203	25	0.05	0.00	0.23	.01	.02	2	0.30
Q51-01																					

TABLE I (concluded)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE WATER CHEMISTRY

STA.NO.	D	DATE	S.D.	T.	ALK	CON	DO	BOD_5	COD	pH	Eh	TS	TDS	CL	NH_3 N	NO_3 N	ORG N	SP	TP	TB	SIO_2
R53-01	0	4/29/67	8.0	4.0	90	320	13.1	1.8	8.5	8.1		226	195	27	0.07	0.08	0.54	.01	.02	--	0.20
R53-01	0	7/30/67	24.0	21.1	100	310	9.1	0.9	5.6	8.7	370	238	234	24	0.15	0.00	0.23	.01	.02	0.2	0.15
R53-01	0	10/23/67	10.0	13.8	101	320	10.5	1.4	8.9	8.4	388	206	205	25	0.06	0.00	0.27	.02	.03	2	0.30
R53-01	0																				
R53-01	32	4/29/67		4.0	95	320	13.0	2.3	8.4	8.0		155	144	27	0.12	0.03	0.29	.02	.03	--	0.20
R53-01	32	7/30/67		21.1	100	310	9.1	1.4	7.2	8.7	370	231	195	26	0.29	0.00	0.18	.01	.02	0.2	0.25
R53-01	31	10/23/67		13.2	97	320	10.2	1.2	8.9	8.2	382	202	200	25	0.09	0.00	0.23	.02	.02	2	0.30
R53-01																					
R53-01	62	4/29/67		4.0	95	320	12.4	1.7	8.9	8.2		156	124	27	0.06	0.06	0.39	.02	.03	--	0.20
R53-01	62	8/30/67		21.0	95	310	9.1	0.8	5.6	8.7	364	229	170	26	0.06	0.00	0.34	.01	.01	0.1	0.15
R53-01	59	10/23/67		12.9	99	330	10.2	1.0	9.3	8.3	388	202	199	25	0.05	0.00	0.23	.02	.02	2	0.25
R53-01																					
S55-01	0	4/29/67	6.0	5.0	100	330	13.2	2.4	8.7	8.4		173	126	26	0.08	0.18	0.39	.04	.05	--	0.40
S55-01	0	7/30/67	16.0	21.3	100	310	9.1	1.0	6.8	8.8	418	225	220	25	0.06	0.00	0.55	.01	.01	0.3	0.15
S55-01	0	10/23/67	11.0	13.6	99	320	10.8	1.2	8.9	8.3	382	205	191	25	0.03	0.00	0.44	.01	.02	2	0.35
S55-01	0																				
S55-01	21	4/29/67		5.0	100	320	13.2	2.2	8.7	8.2		173	141	26	0.10	0.18	0.49	.04	.06	--	0.50
S55-01	21	7/30/67		21.0	95	310	9.1	1.3	8.6	8.7	400	218	215	26	0.03	0.00	0.58	.01	.01	0.3	0.20
S55-01	21	10/23/67		13.2	100	320	10.6	1.2	8.9	8.2	370	206	202	25	0.05	0.00	0.23	.02	.02	2	0.25
S55-01																					
S55-01	40	4/29/67		5.0	100	330	13.1	2.9	12.5	8.3		179	147	26	0.11	0.11	0.58	.09	.13	--	0.50
S55-01	40	7/30/67		21.2	95	310	9 0.1	0.9	9.2	8.7	424	207	202	26	0.08 4	0.00	0.29	.00	.01	0.3	0.20
S55-01	38	10/23/67		12.9	97	320	10.2	0.9	8.3	8.2	370	217	207	25	0.09 6	0.00	0.23	.01	.02	2	0.35
S55-01																					

TABLE 2

DETROIT PROGRAM OFFICE
WATER CHEMISTRY - WESTERN BASIN - 1967

STA. NO.	DATE	D	T	CON	CL	Phenols	D.O.	Total P	Sol. P	NO_3-N	NH_3-N	ORG-N	Total Coliform	SS	Sulfate
L6	4/20/67	0	7.5	220	9	8	11.2	.03	.00	0.6	0.41	0.05	490	11	--
	6/07/67	0	18.5	280	25	1	7.7	.16	.14	0.3	0.32	--	5,400	2	19
	6/20/67	0	19.0	240	13	8	8.0	.07	.05	0.3	0.32	<0.05	2,200	26	17
L8	4/20/67	0	9.5	380	39	5	11.3	.06	.05	1.6	1.12	0.25	340	14	--
	6/07/67	0	19.0	260	19	5	9.2	.10	.08	0.2	--	0.36	130	1	19
	6/20/67	0	19.0	240	13	6	10.8	.07	.05	0.3	0.24	<0.05	1,900	16	17
L9	4/20/67	0	8.5	315	32	6	11.4	.06	.01	0.7	0.35	0.05	13,000	14	--
	6/07/67	0	18.0	220	10	1	9.4	.09	.05	0.2	--	0.27	120	2	17
	6/20/67	0	20.0	260	17	6	7.6	.07	.06	0.2	0.31	< .05	300	20	17
L11	4/20/67	0	8.5	260	19	7	11.5	.04	.02	1.3	0.23	< 0.05	110	8	--
	6/07/67	0	20.0	270	21	21	10.6	.04	.07	0.2	0.23	.36	94	4	19
	6/20/67	0	20.5	320	24	9	7.0	.13	.08	0.2	0.41	< 0.05	490	27	24
L14	4/20/67	0	11.5	540	28	5	10.3	.07	.01	3.6	0.34	0.18	10,000	70	--
	6/07/67	0	21.0	320	25	10	9.9	.08	.06	0.9	0.47	0.23	36	4	31
	6/20/67	0	21.0	300	20	1	7.5	.10	.07	0.6	0.32	< 0.05	3,200	28	24
L17	4/20/67	0	8.0	230	10	12	11.5	.02	.01	1.4	0.19	< 0.05	70	10	--
	6/07/67	0	20.0	290	23	14	11.5	.07	.05	0.4	0.25	0.31	<2	6	25
	6/20/67	0	21.5	280	18	3	7.5	.09	.12	0.3	0.25	< 0.05	5,600	22	22
L21	4/20/67	0	8.5	350	42	12	12.1	.07	.05	0.5	0.47	0.07	800	17	--
	6/07/67	0	19.0	320	35	8	7.7	.21	.16	0.3	0.49	--	1,800	9	20
	6/20/67	0	20.5	260	20	2	6.8	.16	.14	0.5	0.52	< 0.05	14,000	8	19

TABLE 2 (continued)

DETROIT PROGRAM OFFICE
WATER CHEMISTRY - WESTERN BASIN - 1967

STA. NO.	DATE	D	T	CON	CL	Phenols	D.O.	Total P	Sol. P	NO_3-N	NH_3-N	ORG-N	Total Coliform	SS	Sulfate
L23	4/20/67	0	10.5	350	34	6	10.8	.05	.02	1.6	0.26	0.21	720	10	--
	6/07/67	0	21.0	310	29	6	9.6	.11	.09	0.1	0.26	--	390	6	25
	6/20/67	0	20.5	360	33	4	7.6	.22	.12	0.7	0.75	0.14	480	31	31
L26	4/20/67	0	10.5	450	26	4	10.6	.07	.04	3.3	0.60	0.25	140	42	--
	6/07/67	0	20.5	360	23	1	9.9	.09	.07	1.6	0.10	0.23	20	20	42
	6/20/67	0	21.5	340	22	<1	7.0	.13	.09	1.3	0.33	0.19	82	58	39
L40	4/20/67	0	8.0	240	21	7	12.0	.02	.01	0.9	0.09	0.05	> 68	5	--
	6/07/67	0	20.0	255	16	3	10.6	.05	.03	0.4	0.13	0.36	< 2	3	19
	6/20/67	0	21.0	260	17	1	8.6	.05	.04	0.2	0.13	0.16	14	12	19
L41	4/20/67	0	8.5	285	27	6	12.4	.02	.02	0.8	0.10	0.09	30	13	--
	6/07/67	0	20.5	320	24	<1	10.6	.08	.05	1.2	0.13	0.34	< 2	2	31
	6/20/67	0	21.5	260	17	8	7.4	.09	.07	0.4	0.14	0.16	24	39	20
L42	4/20/67	0	8.5	230	15	8	11.7	.01	.01	0.9	0.41	0.27	130	12	--
	6/07/67	0	20.0	335	22	3	10.3	.06	.04	1.4	0.16	0.45	2	5	35
	6/20/67	0	22.0	320	20	< 1	6.3	.21	.11	0.9	--	0.06	20	68	27
L43	4/20/67	0	9.0	275	22	10	11.8	.04	.02	1.0	1.35	0.27	100	16	--
	6/07/67	0	20.0	325	23	1	10.9	.07	.05	1.1	0.14	0.92	2	7	32
	6/20/67	0	22.0	340	21	4	6.7	.31	.12	1.2	--	0.13	130	65	35
L50	4/17/67	0	8.5	280	18	5	11.9	.02	.01	1.1	0.26	0.10	1,300	17	--
	6/13/67	0	21.5	--	26	3	9.5	.02	.01	0.2	0.22	0.13	180	5	19
	7/10/67	0	23.0	280	23	-	9.8	.16	.10	--	0.18	0.11	58	3	17
	8/16/67	0	21.5	340	41	8	9.4	.03	.01	<.1	0.11	0.16	730	5	20

TABLE 2 (continued)

DETROIT PROGRAM OFFICE
WATER CHEMISTRY - WESTERN BASIN - 1967

STA. NO.	DATE	D	T	CON	CL	Phenols	D.O.	Total P	Sol. P	NO_3-N	NH_3-N	ORG-N	Total Coliform	SS	Sulfate
L51	4/17/67	0	7.5	270	19	6	12.0	.01	.01	0.7	0.26	0.21	2	4	--
	6/13/67	0	20.0	--	25	4	9.7	.01	.01	0.1	0.16	0.41	6	4	17
	7/10/67	0	22.0	240	15	-	11.8	.11	.09	--	0.12	--	26	1	18
	8/16/67	0	21.0	280	28	4	9.5	.01	.01	0.1	0.12	0.17	150	4	16
L52	4/17/67	0	6.5	290	24	8	12.5	.02	.02	0.3	0.19	0.16	1	2	--
	6/13/67	0	22.0	--	22	3	9.5	.02	.01	0.2	0.28	0.14	3	0	20
	7/10/67	0	23.0	280	20	-	10.9	.22	.13	--	0.07	0.14	1	2	19
	8/16/67	0	22.0	270	27	5	9.6	.01	.01	0.1	0.09	0.14	11	8	16
L53	4/17/67	0	6.0	290	23	5	12.4	.03	.01	0.2	0.17	0.13	<1	1	--
	6/13/67	0	20.0	--	20	1	9.5	.02	.00	0.1	0.13	0.09	15	1	19
	7/10/67	0	22.0	280	19	-	9.9	.25	.12	--	0.26	0.22	20	1	19
	8/16/67	0	22.0	260	22	16	10.4	.02	.01	0.3	0.32	--	<1	6	18
L54	6/13/67	0	20.0	--	19	-	9.7	.02	.03	0.2	0.21	0.14	1	4	22
	7/10/67	0	22.0	280	20	-	8.4	.12	.12	--	0.09	0.13	70	1	20
	8/16/67	0	22.0	280	23	5	11.1	.02	.01	<.1	0.13	0.23	70	2	19
L55	6/13/67	0	21.0	--	19	1	9.8	.03	.03	0.2	0.15	0.18	4	0	22
	7/10/67	0	22.0	300	20	-	8.5	.15	.14	--	0.17	0.10	6	1	21
	8/16/67	0	22.0	280	24	4	10.0	.02	.01	<.1	0.15	0.28	2	3	20
L56	6/13/67	0	21.5	--	17	2	9.6	.02	.02	0.2	0.47	0.11	4	0	20
	7/10/67	0	22.5	320	21	-	9.6	.17	.09	--	0.18	0.14	<1	3	22
	8/16/67	0	22.0	300	27	3	9.9	.02	.01	<.1	0.07	0.20	70	4	21

TABLE 2 (concluded)

DETROIT PROGRAM OFFICE
WATER CHEMISTRY - WESTERN BASIN - 1967

STA. NO.	DATE	D	T	CON	CL	Phenols	D.O.	Total P	Sol. P	NO_3-N	NH_3-N	ORG-N	Total Coliform	SS	Sulfate
L57	6/13/67	0	22.0		21	1	9.2	.02	.00	0.3	0.68	0.13	< 2	1	22
	7/10/67	0	22.5	320	21	-	9.0	.14	.08	--	0.21	0.34	40	9	24
	8/16/67	0	22.0	320	28	8	9.8	.01	.00	<.1	0.18	0.16	1	9	24
L58	4/17/67	0	7.5	275	20	7	12.4	.02	.01	0.4	0.17	0.18	<2	1	--
	6/13/67	0	23.0	--	21	-	8.4	.03	.02	0.4	--	--	6	0	24
	7/10/67	0	23.0	330	23	-	9.0	.14	.08	--	0.10	--	40	2	23
	8/16/67	0	23.0	330	31	4	10.1	.01	.00	<.1	0.05	0.16	<1	3	23
L59	4/17/67	0	8.0	255	18	6	11.9	.01	.01	0.3	0.23	0.11	2	1	--
	6/13/67	0	24.5	--	19	5	9.9	.01	.01	1.1	0.15	0.09	<2	3	29
	7/10/67	0	23.0	280	21	-	9.5	.14	.09	--	0.09	0.13	1	1	17
	8/16/67	0	24.0	320	24	3	10.0	.03	.00	<.1	0.41	0.06	<1	1	20
L60	4/17/67	0	8.5	265	20	8	12.4	.03	.01	0.8	0.27	0.13	22	5	--
	6/13/67	0	25.0	--	20	<1	9.6	.01	.01	0.7	0.18	0.27	<2	0	23
	7/10/67	0	--	280	18	-	11.9	.13	.10	--	0.10	0.13	50	2	16
	8/16/67	0	24.0	300	20	5	12.0	.04	.01	<.1	0.06	0.14	2	5	17
L61	4/17/67	0=	8.5	310	18	6	12.8	.03	.01	1.3	0.05	0.59	360	9	--
	6/13/67	0	24.5	--	20	21	9.9	.02	.02	0.3	0.41	0.22	<2	0	20
	7/10/67	0	--	290	19	-	9.8	.15	.08	--	0.08	0.10	11	2	15
	8/16/67	0	24.0	280	18	5	11.5	.07	.04	0.2	0.07	0.18	90	5	16
L62	4/17/67	0	9.5	310	18	<1	12.3	.04	.01	1.4	0.18	0.14	320	24	--
	6/13/67	0	22.0	--	25	<1	9.7	.01	.00	0.3	0.08	0.23	6	3	15
	7/10/67	0	21.5	320	23	-	8.9	--	--	--	0.06	0.08	420	5	17
	8/16/67	0	24.0	300	15	4	9.0	.01	.01	0.4	0.07	0.15	68	6	16

TABLE 3

WATER CHEMISTRY COMPARISONS 1963-64 - 1967-68
(Cleveland Program Office Data)

		Western Basin			%	Central Basin			%	Eastern Basin			%	Total
		max.	min.	avg.	Change	max.	min.	avg.	Change	max.	min.	avg.	Change	Lake Avg.
Conductivity	1963-64	364	196	272		353	260	300		328	284	301		298.9
	1967-68	370	238	285	+4.8	330	283	312	+3.7	333	310	318	+5.6	312.6
Dissolved Solids	1963-64	220	110	162		239	137	178		233	150	179		177.6
	1967-68	247	135	170	+4.9	283	147	196	+10.1	297	138	204	+14.0	197.3
Total Solids	1963-64	250	140	181		218	159	185		240	167	188		185.8
	1967-68	356	149	188	+3.9	307	153	202	+9.2	308	175	220	+17.0	207.1
Chlorides	1963-64	34	10	21		46	19	24		31	21	24		23.9
	1967-68	26	10	19	-9.5	29	19	23	-4.2	28	24	25	+4.2	23.4
Silica	1963-64	5.0	0.3	1.20		9.6	0.2	0.68		3.5	0.2	0.47		0.64
	1967-68	1.87	0.43	1.06	-11.7	0.98	0.15	0.37	-45.6	0.72	0.18	0.37	-21.2	0.40
Soluble Phosphorus	1963-64	0.33	0.00	0.03		0.07	0.00	0.01		0.04	0.00	0.01		0.011
	1967-68	0.10	0.01	0.04	+33.3*	0.03	0.00	0.02	+100.0*	0.02	0.01	0.01	0.0	0.018
Total Phosphorus	1963-64	--	--	--		--	--	--		--	--	--		
	1967-68	0.19	0.02	0.06		0.05	0.01	0.02		0.08	0.01	0.02		0.022
Total Nitrogen	1963-64	2.66	0.17	0.71		1.30	0.07	0.43		1.18	0.10	0.42		0.44
	1967-68	1.98	0.27	0.74	+4.2	0.95	0.28	0.47	+9.3	0.75	0.30	0.47	+11.9	0.48
Organic Nitrogen	1963-64			0.36				0.25				0.24		0.25
	1967-68	0.71	0.07	0.37	+2.3	0.78	0.12	0.32	+28.0*	0.55	0.21	0.34	+41.6*	0.33

TABLE 3 (Concluded)

WATER CHEMISTRY COMPARISONS 1963-64 - 1967-68
(Cleveland Program Office Data)

		Western Basin			%	Central Basin			%	Eastern Basin			%	Total
		max.	min.	avg.	Change	max.	min.	avg.	Change	max.	min.	avg.	Change	Lake Avg.
Ammonia Nitrogen	1963-64	0.77	0.01	0.16		0.39	0.00	0.09		0.32	0.00	0.09		0.09
	1967-68	0.56	0.04	0.17	+6.3	0.21	0.02	0.10	9.0	0.17	0.04	0.07	-22.2	0.09
Nitrate Nitrogen	1963-64	1.50	0.02	0.12		0.84	0.00	0.09		0.85	0.01	0.09		0.09
	1967-68	0.96	0.01	0.20	66.7*	0.43	0.00	0.05	-44.4	0.16	0.00	0.06	-33.3	0.06
Chemical Oxygen Demand	1963-64	29.0	1.1	10.4		16.0	3.1	7.1		27.0	4.7	7.4		7.36
	1967-68	18.9	5.5	9.8	-5.8	11.9	5.2	8.6	+21.1*	11.0	6.1	8.2	+10.8	8.53
5-Day Biochemical Oxygen Demand	1963-64	--	--	--		--	--	--		--	--	--		
	1967-68	4.1	0.4	1.7		2.7	0.0	1.0		2.5	0.2	1.2		1.10
Alkalinity	1963-64	240	57	99		130	71	97		134	59	99		
	1967-68	105	75	90	-9.9	102	92	96	-1.0	109	92	98	-1.0	96.3
Eh	1963-64	--	--	--		--	--	--		--	--	--		
	1967-68	560	474	511		612	354	470		444	324	385		445
pH	1963-64													
	1967-68	8.8	7.6	8.3		8.9	7.7	8.4		8.7	7.5	8.3		8.36

* Eliminated from average to insure statistical validity.

TABLE 4

DETROIT PROGRAM OFFICE

MICHIGAN WATERS OF LAKE ERIE
COMPARATIVE DATA - 1963 and 1967

		Max.	Min.	Avg.
Conductivity	1963	--	--	--
	1967	540	220	296
Chlorides	1963	46	14	25
	1967	42	9	23
Phenols	1963	16	0	3
	1967	21	<1	6
Total Phosphorus	1963	0.25	0.04	0.08
	1967	0.31	0.01	0.09
Soluble Phosphorus	1963	--	--	--
	1967	0.16	0.00	0.06
Nitrate Nitrogen	1963	0.5	0.1	0.3
	1967	3.6	<0.1	0.9
Ammonia Nitrogen	1963	0.58	0.05	0.25
	1967	1.35	<0.05	0.37
Organic Nitrogen	1963	0.62	0.08	0.25
	1967	0.92	<0.05	0.18
Suspended Solids	1963	--	--	--
	1967	70	0	19
Sulfate	1963	--	--	--
	1967	42	15	25

TABLE 5

DETROIT AND CLEVELAND PROGRAM OFFICES

COMPARISON OF 1967-68 CLEVELAND AND DETROIT DATA FOR WESTERN BASIN

		Basin Average	Combined Average
Conductivity	DPO	296	290
	CPO	285	
Chlorides	DPO	22	20
	CPO	19	
Total Phosphorus	DPO	0.07	.06
	CPO	0.06	
Soluble Phosphorus	DPO	0.05	.04
	CPO	0.04	
Nitrate-N	DPO	0.6	0.4
	CPO	0.2	
Ammonia-N	DPO	0.28	0.22
	CPO	0.17	
Organic-N	DPO	0.18	0.27
	CPO	0.37	
Suspended Solids	DPO	11	14
	CPO	17	

In the central basin, all chemical constituents show increases except chlorides, silica, and nitrate nitrogen, while in the eastern basin the only decreases are in silica, ammonia nitrogen, and nitrate nitrogen.

The average dissolved solids have increased 9 percent during this period in spite of the fact that chlorides and silica have decreased. The average specific conductance has also increased indicating that the increase in dissolved solids is due to inorganic constituents. Future work will endeavor to describe these inorganic constituents. Silica is apparently paralleled by extensive increases in diatom populations in each basin. Diatoms metabolically assimilate dissolved silica in skeletal formation.

SEDIMENT CHEMISTRY

The role of bottom sediments in Lake Erie, as in other temperate, eutrophic lakes, has great significance especially during summer thermal stratification. During this period, convective mixing between the temperature-density stratified water is severely limited. The bottom layer, isolated from atmospheric replenishment, eventually becomes depleted of dissolved oxygen due to uptake by sedimented plankton. This leads directly to an accelerated nutrient cycle between sediment and water.

With development of anaerobic conditions at the sediment-water interface, the reduced forms of iron, manganese, and sulfur, along with phosphorus, ammonia, and carbon dioxide are leached from the sediment to the overlying waters. The effect is a nutritional stimulus to plankton. The death and sedimentation of these plankton renew the sources of sediment organic matter, which are again bacteriologically degraded in a succeeding stratification leading to another hypolimnetic deoxygenation and nutritional enrichment.

It is suspected that a lake can reach a state of eutrophication or enrichment whereby, in spite of elimination of all waste inputs, the bottom sediments become such that the above cycle would be indefinitely perpetuated.

In an attempt to study the state of eutrophication in Lake Erie, bottom sediments were analyzed during the various seasons of the year, (see Table 6). A comparison with respect to basin averages for the years 1963-64, and 1967-68, is given in Table 7.

Substantial increases in sediment phosphorus and ammonia nitrogen were noted in all basins. Sediment organic nitrogen increased in the western and eastern basins while decreasing in the central. Sediment nitrate nitrogen showed decreases in the central and eastern basins while remaining constant in the western.

TABLE 6

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE SEDIMENT CHEMISTRY

STA. NO.	D	DATE	pH	Eh	T	BOD_5	IDOD	COD	%VS	TP	NH_3-N	NO_3-N	ORG-N	TFE
D09-01	44	5/03/67	7.5		9.0	--	--	--	--	--	--	--	--	--
D09-01	64	7/28/67	5.1		20.0	3.8	--	80.4	9.7	--	0.64	0.0000	3.79	41.56
D09-01	46	10/18/67	7.1		12.7	2.0	0.8	65.3	10.2	2.19	0.41	0.0018	1.90	
D09-01														
D13-01	46	5/02/67	7.5		6.0	--	--	--	--	--	--	--	--	--
D13-01	49	7/28/67	5.1		16.0	1.6	--	55.0	6.3	--	0.17	0.0002	0.06	27.31
D13-01	46	10/18/67	7.0		13.5	1.0	0.4	31.4	4.6	0.67	0.15	0.0015	0.86	--
D13-01	47	1/12/68	7.4	478	2.2	1.6	0.2	74.9	8.5	0.93	0.11	0.0016	2.06	30.31
E02-01	28	5/04/67	7.2		11.0	--	--	--	--	--	--	--	--	--
E02-01	31	7/26/67	--		23.0	2.1	--	109.1	7.3	--	0.20	0.0000	2.36	27.78
E02-01	34	10/16/67			12.5	2.1	0.3	74.4	7.8	1.13	0.48	0.0017	2.00	--
E02-01	32	1/09/68	7.8	274	1.8	1.7	0.2	74.0	7.5	1.26	0.23	0.0008	1.91	28.75
E05-01	24	5/04/67	8.5		8.5	--	--	--	--	--	--	--	--	--
E05-01	26	7/27/67	4.4		--	0.9	--	27.2	3.1	--	0.08	0.0000	0.90	19.30
E05-01	25	10/17/67	7.3		12.5	1.0	0.4	30.5	6.0	0.66	0.33	0.0007	1.04	--
E05-01	26	1/10/68	7.3	370	2.0	3.1	0.5	83.3	8.3	1.23	0.38	0.0019	2.58	42.14
F03-01	33	5/04/67	--		--	--	--	--	--	--	--	--	--	--
F03-01	34	7/26/67	--		21.9	3.1	--	89.2	8.0	--	0.49	0.0005	3.59	37.80
F03-01	32	10/16/67			13.4	2.2	0.5	71.3	14.5	0.95	0.55	0.0012	2.28	--
F03-01	33.5	1/09/68	7.8	418	1.5	1.4	0.1	56.5	7.2	0.86	0.19	0.0011	1.38	29.60
F03-02	26	5/04/67	7.6		9.0	--	--	--	--	--	--	--	--	--
F03-02	25	7/27/67	3.7		21.5	2.3	--	84.1	8.1	--	0.42	0.0003	2.82	35.53
F03-02	25	10/17/67	7.4		12.8	1.6	0.7	70.0	10.2	0.77	0.37	0.0010	1.87	--
F03-02	32	1/09/68	7.9	130	1.6	2.2	0.4	82.8	9.5	0.97	0.39	0.0012	2.19	36.38

TABLE 6 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE SEDIMENT CHEMISTRY

STA. NO.	D	DATE	pH	Eh	T	BOD_5	IDOD	COD	%VS	TP	NH_3-N	NO_3-N	ORG-N	TFE
F16-01	61	5/02/67	8.5		--	--	--	--	--	--	--	--	--	--
F16-01	62	7/28/67	5.7		10.0	1.2	--	46.2	5.6	--	0.15	0.0002	2.07	33.62
F16-01	60	10/18/67	7.1		14.2	1.1	0.5	47.2	7.4	0.63	0.33	0.0013	1.64	--
F16-01	63	1/13/68	7.5	430	2.6	1.0	0.3	50.2	6.7	0.56	0.19	0.0024	1.71	37.12
G04-01	28	5/04/67	7.4		9.5	--	--	--	--		--	--	--	--
G04-01	30	7/27/67	4.9		20.5		--	29.0	3.1		0.05	0.0000	0.08	34.38
G04-01	30.5	10/17/67	7.4			1.1	0.7	61.4	8.6	0.75	0.38	0.0010	1.72	--
G04-01	29	1/09/68	8.0	274	1.0	0.6	0.1	27.1	4.8	0.48	0.07	0.0009	0.68	15.63
G06-01	32	5/04/67	8.1		8.0	--	--	--	--		--	--	--	--
G06-01	34	7/27/67	4.2		19.0	2.0	--	76.1	7.7		0.24	0.0003	2.61	20.05
G06-01	32	10/17/67	7.2		12.5	0.8	0.7	94.7	8.8	0.82	0.38	0.0006	1.89	--
G06-01	32	1/10/68	7.8	--	2.4	1.7	0.4	78.6	8.9	0.82	0.32	0.0014	1.86	41.40
G07-01	49	5/03/67	7.8		8.5	--	--	--	--		--	--	--	--
G07-01	36	7/27/67	5.0		20.0	1.9	--	75.1	7.9		0.28	0.0046	2.61	33.90
G07-01	34	10/17/67	7.3		12.5	0.7	0.5	64.3	11.8	0.66	0.31	0.0006	1.62	--
G07-01	35	1/10/68	7.9	310	2.1	1.7	0.5	81.8	10.0	0.65	0.35	0.0020	2.44	36.84
G09-01	37	5/03/67	7.0		8.0	--	--	--	--		--	--	--	--
G09-01	36	7/27/67	4.6		21.0	1.4	--	55.9	6.3		0.24	0.0007	0.07	32.28
G09-01	36	10/18/67	7.3		12.0	1.4	0.5	60.9	9.6	0.87	0.41	0.0008	1.94	--
G09-01	38	1/11/68	7.7	88	1.9	0.8	0.2	46.3	4.9	0.48	0.11	0.0005	1.49	29.22
G10-01	38	5/03/67	6.9		--	--	--	--	--	--	--	--	--	--
G10-01	36	7/28/67	4.8		20.0	1.4	--	54.0	6.1	--	0.28	0.0016	2.33	30.20
G10-01	40	10/18/67	7.4		12.5	0.8	0.5	51.6	8.0	0.62	0.29	0.0005	1.43	--
G10-01	39	1/11/68	7.4	202	2.6	1.1	0.3	56.3	8.3	0.35	0.18	0.0007	1.72	32.69

TABLE 6 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE SEDIMENT CHEMISTRY

STA. NO.	D	DATE	pH	Eh	T	BOD_5	IDOD	COD	%VS	TP	NH_3-N	NO_3-N	ORG-N	TFE
G12-01	42	5/03/67	--	--	--	--	--	--	--		--	--	--	
G12-01		7/28/67	--	--	--	--	--	--	--		--	--	--	
G12-01		10/18/67	--	--	--	--	--	--	--		--	--	--	
G12-01		1/12/68												
G18-01	73	5/01/67	7.0		--	--	--	--	--	--	--	--	--	
G18-01	74	7/28/67	5.2		10.0	0.8	--	71.3	7.1	--	0.64	0.0037	3.21	40.26
G18-01	72	10/19/67	6.9		13.5	1.1	0.7	48.2	7.4	0.77	0.43	0.0014	1.92	
G18-01	73	1/13/68	7.4	466	2.1	1.5	0.6	74.5	8.4	0.71	0.34	0.0032	2.96	42.87
H20-01	79	5/01/67	7.5		6.0	--	--	--	--		--	--	--	
H20-01	81	7/28/67	5.1		10.0	2.8	--	81.9	8.4		0.57	0.0021	4.02	36.38
H20-01	78	10/19/67	7.0		13.5	1.3	0.9	75.9	8.7	0.78	0.58	0.0026	2.59	
H20-01														
I23-01	80	5/01/67	7.2		--	--	--	--	--		--	--	--	
I23-01	82	7/29/67	7.4		10.0	2.5	--	70.7	6.7		0.55	0.0033	3.23	78.83
I23-01	80	10/19/67	7.0		13.5	1.2	0.8	64.4	8.0	0.90	0.47	0.0039	2.00	
I23-01														
J25-01	77	5/01/67	7.8		5.5	--	--	--	--	--	--	--	--	
J25-01	80	7/29/67	7.2		9.0	--	--	70.8	7.8	--	0.44	0.0014	3.06	36.04
J25-01	78	10/20/67	7.9		13.0	1.5	0.7	64.9	9.0	0.79	0.52	0.0012	2.30	
J25-01														
K28-01	75	4/30/67	7.1		--	--	--	--	--	--	--	--	--	
K28-01	76	7/29/67	7.1		9.0	1.4	--	41.5	4.6	--	0.22	0.0021	1.79	28.25
K28-01	74	10/20/67	6.9		13.0	0.8	0.3	40.0	6.4	0.74	0.24	0.0008	1.34	
K28-01														

TABLE 6 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE SEDIMENT CHEMISTRY

STA. NO.	D	DATE	pH	Eh	T	BOD_5	IDOD	COD	%VS	TP	NH_3-N	NO_3-N	ORG-N	TFE
L30-01	72	4/30/67	8.0		6.0	--	--	--	--	--	--	--	--	
L30-01	74	7/29/67	6.8		10.0	0.4	--	17.4	2.5-	--	0.09	0.0000	0.70	16.74
L30-01	72	10/20/67	7.2		13.0	0.5	0	17.2	5.1	0.84	0.10	0.0016	0.51	
L30-01														
L33-01	70	4/30/67	7.5		--	--	--	--	--	--	--	--	--	
L33-01		7/29/67	--		--	--	--	--	--	--	--	--	--	
L33-01	68	10/22/67	7.2		12.5	0.4	0.1	18.4	2.7	0.67	0.08	0.0002	0.49	
L33-01														
L36-01	70	4/30/67	--		--	--	--	--	--	--	--	--	--	
L36-01		7/29/67	--		--	--	--	--	--	--	--	--	--	
L36-01	70	10/22/67			0.1	0.1	0	9.8	9.3	0.42	0.03	0.0003		
L36-01														
M38-01	74	4/30/67	8.2		4.0	--	--	--	--	--	--	--	--	
M38-01	74	7/30/67	--		--	0.03	--	9.6	1.7	--	0.04	0.0009	0.33	24.70
M38-01	63	10/22/67				0.2	0	6.2	3.3	0.56	0.04	0.0001	0.09	
M38-01														
M41-01	116	4/30/67	7.7		5.5	--	--		--	--	--	--	--	
M41-01	114	7/30/67	7.0		6.0	0	--	18.5	5.7	--	0.04	0.0005	0.03	28.50
M41-01	116	10/22/67	7.4		7.0	0.05	0.05	15.8	7.2	0.76	0.09	0.0006	0.31	
M41-01														
M43-01	144	4/30/67	7.7		--	--	--	--	--	--	--	--	--	
M43-01	140	7/30/67	7.2		4.8	2.7	--	48.2	5.8	--	0.30	0.0005	2.04	38.41
M43-01	140	10/22/67	7.4		6.0	6.7	0.6	53.7	9.8	0.91	0.32	0.0007	1.66	
M43-01														

TABLE 6 (concluded)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE SEDIMENT CHEMISTRY

STA. NO.	D	DATE	pH	Eh	T	BOD_5	IDOD	COD	%VS	TP	NH_3-N	NO_3-N	ORG-N	TFE
N45-01	162	4/29/67	7.4		4.0	--	--	--	--	--	--	--	--	
N45-01	164	7/30/67	7.0		4.8	--	--	63.3	7.0	--	0.45	0.0015	2.31	50.67
N45-01	158	10/23/67	7.3		5.5	1.5	0.9	55.2	11.2	1.10	0.34	0.0007	0.90	
N45-01														
047-01	159	4/29/67	7.5		4.0	--	--	--	--	--	--	--	--	
047-01	178	7/30/67	6.8		4.6	4.2	--	74.8	8.0	--	0.71	0.0027	3.89	40.88
047-01	182	10/23/67	7.2		5.5	1.7	0.7	79.8	8.8	1.49	0.55	0.0016	2.35	
047-01														
P49-01	98	4/29/67	7.4		5.5	--	--	--	--	--	--	--	--	
P49-01	101	7/30/67	7.5		6.0	0.6	--	18.7	2.4	--	0.08	0.0007	0.83	17.55
P49-01	96	10/23/67	7.3		13.5	2.2	0.5	61.8	6.9	0.75	0.40	0.0009	1.63	
P49-01														
Q51-01	74	4/29/67	7.7		5.0	--	--	--	--	--	--	--	--	
Q51-01	76	7/30/67	9.1		10.5	2.7	--	62.2	5.2	--	0.39	0.0007	2.26	38.39
Q51-01	73	10/23/67	7.6		13.5	0.4	0.8	14.8	2.4	0.83	0.10	0.0002	0.40	
Q51-01														
R53-01	64	4/29/67	7.1		5.0	--	--	--	--	--	--	--	--	
R53-01	64	7/30/67	7.2		17.8	1.1	--	40.4	3.9	--	0.20	0.0017	1.44	24.60
R53-01	62.5	10/23/67	7.1		12.9	0.8	0.1	26.2	2.5	0.76	0.19	0.0005	0.68	
R53-01														
S55-01	42	4/29/67	6.8		6.0	--	--	--	--	--	--	--	--	
S55-01		7/30/67	--		--	--	--	--	--	--	--	--	--	
S55-01	42	10/23/67	7.5		17.5	1.0	0.1	37.2	3.0	0.68	0.25	0.0003	0.87	
S55-01														

TABLE 7

SEDIMENT CHEMISTRY COMPARISONS 1963-64 - 1967-68
mg/g
(Cleveland Program Office Data)

		Western Basin			% Change	Central Basin			% Change	Eastern Basin			% Change
		max.	min.	avg.		max.	min.	avg.		max.	min.	avg.	
pH	1963-64	--	--	--		--	--	--		--	--	--	
	1967-68	7.8	6.6	7.0		8.2	6.5	7.2		8.1	7.1	7.4	
BOD	1963-64	--	--	--		--	--	--		--	--	--	
	1967-68	2.9	0.9	1.6		2.0	0.1	1.0		3.1	1.0	1.9	
IDOD	1963-64	--	--	--		--	--	--		--	--	--	
	1967-68	0.8	0.3	0.5		0.9	0.0	0.4		0.9	0.1	0.5	
COD	1963-64	96.0	6.0	63.5		91.0	3.0	55.7		79.0	1.0	27.8	
	1967-68	85.8	39.2	66.1	+4.1	78.9	7.9	41.0	-26.4	77.0	33.3	48.1	+73.0
Volatile Solids	1963-64	543.0	17.0	234.0		748.0	12.0	214.0		301.0	6.0	74.0	
	1967-68	100.0	55.0	81.0	-65.3	93.0	25.0	63.0	-70.6	91.0	30.0	57.0	-23.0
Total Phosphorus	1963-64	1.10	0.29	0.76		1.10	0.13	0.65		1.05	0.12	0.51	
	1967-68	2.19	0.49	0.94	+23.7	0.90	0.42	0.72	+10.8	1.49	0.68	0.93	+82.3
Ammonia Nitrogen	1963-64	0.37	0.04	0.19		0.22	0.00	0.09		0.28	0.00	0.07	
	1967-68	0.53	0.17	0.32	+40.6	0.57	0.03	0.25	+177.8	0.63	0.19	0.32	+357.1
Nitrate Nitrogen	1963-64	.0020	.0000	.0010		.0080	.0000	.0020		.0100	.0000	.0040	
	1967-68	.0024	.0006	.0010	0.0	.0036	.0002	.0014	-30.0	.0022	.0003	.0009	-77.5
Organic Nitrogen	1963-64	0.41	0.05	0.23		9.05	0.08	1.84		2.41	0.00	0.85	
	1967-68	2.85	0.83	1.93	+752.0	3.31	0.17	1.56	-15.2	3.12	0.87	1.58	+85.9
Total Iron	1963-64	68.00	17.00	33.00		72.00	12.00	35.00		45.00	0.02	14.40	
	1967-68	41.56	25.00	32.35	-5.0	78.83	16.74	35.53	+1.5	50.67	17.55	35.08	+143.6

The volatile solids were extremely high during the 1963-64 sampling period indicating the probability of error.

WATER BIOLOGY

PHYTOPLANKTON

Phytoplankton productivity in Lake Erie is highly variable from year to year. The variations result from many factors including nutrient concentration, light intensity, turbidity, and period of sampling (organisms may be in a logarithmic growth stage during sampling period). Since the variables are many, comparison with 1963-64 data will only superficially be made. The 1967 data (see Table 8) will be treated generally to show ranges and to illustrate seasonal variations in productivity and species composition. Only Cleveland Program Office data are available; the Detroit Program Office made no biological evaluations.

The phytoplankton data were averaged for all stations and separated according to basins and seasons. Table 9 illustrates phytoplankton types as related to total phytoplankton for each basin and season.

The data show a spring pulse in the western basin composed primarily of diatoms. Another western basin pulse occurred in fall, primarily of diatoms and green algae. Low-level diatom pulses occurred in spring in the eastern basin, and in summer and winter in the western basin. In each case the dominant diatoms were of the Cyclotella-Stephanodiscus variety. Scenedesmus was the dominant green alga. Table 10 shows average total populations and algal types with reference to basin and season.

The decreasing west to east trend is not as obvious in the 1967-68 data as it was in 1963-64 especially when considering the averages. However, upon further examination of the individual types and numbers, the trend is discernible especially in spring, summer, and fall.

Table 11 shows slightly higher spring 1967 average phytoplankton numbers in the western and eastern basins than in 1963-64. Lower numbers were noted in the central basin in 1967-68. Higher numbers of phytoplankton were noted in the western and central basins in the fall of 1967 than in the fall of 1964. Fall, eastern basin average phytoplankton numbers were similar during both sampling periods.

The fall 1963-64 plankton populations indicate bloom conditions in the western basin, whereas this state of algal productivity was not encountered anywhere during the 1967-68 sampling period. However, conclusions with respect to changes in Lake Erie algal productivity cannot be made without more frequent sampling.

TABLE 8

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
D09-01	0	5/03/67	330	22	242		3124	242	22	--	3982	24	3600
D09-01	0	7/28/67	11	--	407		330	22	--	66	836	28	6000
D09-01	0	10/18/67	--	22	374		924	44	--	--	1364	33	1600
D09-01	0												
D09-01	22	5/03/67	132	44	242		3190	374		22	4004	26	2800
D09-01	32	7/28/67	55	33	110		319	22		22	561	30	4700
D09-01	23	10/18/67	66	22	616		1100	88		--	1892	32	2200
D09-01													
D09-01	42	5/03/67	110	44	352		3762	682	--	44	4994	29	4000
D09-01	62	7/28/67	77	33	187		341	44	77	66	825	31	7500
D09-01	42	10/18/67	66	22	528		1012	22		--	1650	24	1000
D09-01													
D13-01	0	5/02/67	506	22	198		132	44	--	--	902	6	1200
D13-01	0	7/28/67	11	11	44		11	--	88	187	352	20	1900
D13-01	0	10/18/67	--	--	484		88	44	--	--	616	19	2300
D13-01	0	1/12/68	22	11	165		99	154	--	33	484	12	1000
D13-01	23	5/02/67	132	--	198	--	132	22	--	--	484	8	1300
D13-01	36	7/28/67	--	11	33	33	--	11	22	55	165	8	1100
D13-01	23	10/18/67	--	44	550	22	110	110	--	--	836	20	2000
D13-01	23	1/12/68	22	11	176	11	231	253	55	33	792	15	200
D13-01	44	5/02/67	616	66	198	--	88	44	--	--	1012	6	4700
D13-01	47	7/28/67	22	--	33	11	110	66	--	--	242	18	1000
D13-01	42	10/18/67		--	704	--	154	110	--	--	968	20	3000
D13-01	44	1/12/68			330	11	220	209	22	44	836	13	800

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
E02-01	0	5/04/67	176	44	220		2046	374	--	--	2860	49	6900
E02-01	0	7/26/67	198	1320	198		--	66	--	22	1804	14	7100
E02-01	0	10/16/67	22	1100	3758		3476	176	22		8554	73	7700
E02-01	0	1/09/68			66		286	55			407	39	1400
E02-01	14	5/04/67	66	--	484	--	2728	396	22	22	3718	55	6300
E02-01	15	7/26/67	110	1452	220	22	176	132	--		2112	34	3800
E02-01	17	10/16/67	132	572	3564	--	4620	748	88		9724	55	6900
E02-01													
E02-01	26	5/04/67	44	44	418	--	3674	374	66		4620	69	9700
E02-01	29	7/26/67	110	1332	352	--	242	66	--		2102	40	--
E02-01	29	10/16/67	88	220	2376	44	4048	1144	176		8096	130	31400
E02-01	29	1/09/68					132	55			187	55	12000
E05-01	0	5/04/67	44	--	110		2068	484	--	--	2706	53	3700
E05-01	0	7/27/67	22	--	77		88	44	--	88	319	19	3500
E05-01	0	10/17/67	22	44	572		902	22	110		1672	21	300
E05-01	0	1/10/68	11		22		330	286	11		660	7	300
E05-01	12	5/04/67	110	22	88		1804	330	22	--	2376	51	1300
E05-01	13	7/27/67	11	22	22		55	--		44	154	15	4300
E05-01	12	10/17/67	88	44	308		220	--		--	660	18	4500
E05-01	13	1/10/68		33	33		561	231		11	869	14	600
E05-01	22	5/04/67	110	22	132		1540	286		22	2112	50	1500
E05-01	24	7/27/67	22	22	22		88	11		33	198	19	2600
E05-01	21	10/17/67	22	11	165		451	--			649	16	4000
E05-01	23	1/10/68			88		550	330			968	8	400

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M³	mg/M³
F03-01	0	5/04/67	44	44	66		1738	286	22	132	2332	44	4800
F03-01	0	7/26/67	110	154	132		264	22	--	22	704	19	3300
F03-01	0	10/16/67	440	616	2376		1012	176	44		4664	22	5700
F03-01	0	1/09/68		11	77		1210	231	11		1540	18	2000
F03-01	16	5/04/67	66	22	242		1430	286		22	2068	47	4400
F03-01	17	7/26/67	88	220	44		374	44		154	824	22	6700
F03-01	17	10/16/67	352	484	1892		1232	220			4180	15	6000
F03-01	16	1/09/68			154		1155	187			1518	17	5000
F03-01	30	5/04/67	44	22	242	--	2090	154	--	66	2618	51	4800
F03-01	32	7/26/67	--	110	242	--	220	110	--	110	892	15	6000
F03-01	29	10/16/67	220	1100	3036	132	1760	352	88	--	6688	94	11300
F03-01	30	1/09/68			66		1386	253		11	1716	24	1000
F03-02	0	5/04/67	264	22	682	--	2288	264		--	3520	51	3200
F03-02	0	7/27/67	22	66	88	22	66	22		22	308	16	4200
F03-02	0	10/17/67	--	22	902	22	1518	154			2618	24	2300
F03-02	0	1/09/68		22	110		737	286			1210	8	800
F03-02	13	5/04/67	88	--	132		1474	264	--	--	1958	53	2500
F03-02	12	7/27/67	--	22	44		176	66	--	22	330	14	300
F03-02	12	10/17/67	33	11	187		231	--	11		473	16	2000
F03-02	16	1/09/68	11	11	33		341	297	11		704	16	1600
F03-02	24	5/04/67	88	--	154		1298	330		--	1870	51	4000
F03-02	23	7/27/67	22	66	88		242	44		44	506	19	1900
F03-02	20	10/17/67	88	22	1034		990	132		--	2266	21	2000
F03-02	29	1/09/68	11		55		407	264		22	759	20	1600

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
F16-01	0	5/02/67	154	--	176	--	286	44	--	--	660	14	1000
F16-01	0	7/28/67	--	33	88	44	--	11	--	66	242	10	900
F16-01	0	10/18/67	--		198		88	407	--	--	693	18	2200
F16-01	0	1/13/68	55		176		220	253	11	55	770	14	300
F16-01	30	5/02/67	154	--	220	--	176	286		--	836	13	400
F16-01	48	7/28/67	33	--	88	77	11	11		--	220	4	1200
F16-01	30	10/18/67	--	--	187	--	11	99		--	297	18	1000
F16-01	31	1/13/68	11	11	132	11	308	220		22	715	13	300
F16-01	59	5/02/67	132	--	220	--	308	154	--	88	902	12	1400
F16-01	60	7/28/67	11	--	77	66	22	22	22	--	220	3	300
F16-01	56	10/18/67	--	11	198	--	154	143	--	22	528	24	1300
F16-01	60	1/13/68	22		242	11	473	363	11	22	1144	19	100
G04-01	0	5/04/67	22	--	88		2046	440	44		2640	41	3300
G04-01	0	7/27/67	--	44	594	66	1276	132	66		2178	32	3700
G04-01	0	10/17/67	132	154	1782	44	2354	242	44		4752	51	13800
G04-01	0	1/09/68		22	44	--	88	77			231	11	1000
G04-01	14	5/04/67			66		1650	374		--	2090	40	2900
G04-01	15	7/27/67	66	44	638	66	2048	88	88	--	3038	31	4000
G04-01	15	10/17/67	88	66	858	--	2178	220	44	--	3454	50	5500
G04-01	15	1/09/68			77	11	275	77	11	11	462	12	4700
G04-01	26	5/04/67	88	22	66		2816	638		22	3652	37	5100
G04-01	28	7/27/67	44	--	462	44	1034	44	22	--	1650	32	7500
G04-01	26	10/17/67	264	88	2200	88	2464	88	44	--	5236	49	5300
G04-01	26	1/09/68	11		44	11	88	165	11	44	374	19	6700

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TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M³	mg/M³
G06-01	0	5/04/67	44	--	44	--	1144	220	--		1452	21	600
G06-01	0	7/27/67	44	154	462	110	1584	44	--		2398	39	6000
G06-01	0	10/17/67		22	176		1254	154	66		1672	13	4300
G06-01	0	1/10/68				11	88	143			162	10	4000
G06-01	16	5/04/67	66	22	22	--	682	286		--	1078	17	4600
G06-01	27	7/27/67	132	44	1320	66	1870	66		--	3498	39	4300
G06-01	16	10/17/67	176		220		1430	44		--	1870	16	3300
G06-01	16	1/10/68			44		99	88		11	242	6	7000
G06-01	30	5/04/67	22		44	--	880	352		22	1320	21	5000
G06-01	32	7/27/67	110		924	22	1518	220		--	2794	34	4000
G06-01	28	10/17/67	22		154	--	462	--		--	638	15	2900
G06-01	29	1/10/68			11	11	165	110		22			3500
G07-01	0	5/03/67	88		66	--	2530	418	--	22	3124	33	4100
G07-01	0	7/27/67	66		308	44	66	66	176		726	14	250
G07-01	0	10/17/67	--		154		682	22			858	13	
G07-01	0	1/10/68	22		66		99	66			253	13	5000
G07-01	25	5/03/67	88		220	--	3278	484	--	22	4092	25	2500
G07-01	18	7/27/67	22		308	--	55	66	220		671	13	1800
G07-01	17	10/17/67	--		154	--	264	22			440	15	900
G07-01	17	1/10/68	11		44	11	165	44			275	17	1300
G07-01	47	5/03/67	110	88	88		2486	374	--	22	3168	31	4700
G07-01	34	7/27/67	11	22	231		33	55	176		528	13	1800
G07-01	30	10/17/67			176		594	--	22		792	14	1100
G07-01	32	1/10/68					121	88			209	8	6700

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M³.	mg/M³
G09-01	0	5/03/67	132		110	--	308	44		110	704	12	1900
G09-01	0	7/27/67	33		99	11	11	11		--	165	5	400
G09-01	0	10/18/67	66		132		308	110		--	616	12	300
G09-01	0	1/11/69	22		22		132	242		22	440	10	1200
G09-01	18	5/03/67	22	--	66	--	572	66		88	814	9	3600
G09-01	18	7/27/67		--	--	--	--	--			--	6	800
G09-01	18	10/18/67		22	154	--	396	44			616	11	300
G09-01	19	1/11/68			33	11	198	143			385	7	3200
G09-01	35	5/03/67	22	--	22		396	44	--	44	528	12	1900
G09-01	34	7/27/67	11	22	132		308	66	--	22	561	6	1000
G09-01	32	10/18/67	33	--	176		385	77	--	22	693	10	700
G09-01	35	1/11/68		22	11		77	231	11		352	9	1400
G10-01	0	5/03/67	--	--	44		220	22	--	154	440	8	7200
G10-01	0	7/28/67	--	--	44		110	11	--	--	165	8	800
G10-01	0	10/18/67	11	11	319		704	88	--	--	1133	26	500
G10-01	0	1/11/68	11		55		187	264	11	22	550	9	500
G10-01	19	5/03/67	22	--	66		352	22	--	44	506	9	7700
G10-01	18	7/28/67	7	--	37		80	--	--	--	124	9	2700
G10-01	20	10/18/67		22	352		726	66	286	--	1452	13	200
G10-01	19	1/11/68		11	11		242	99	33	11	407	7	500
G10-01	36	5/03/67	--	--	44	--	506	88	--	44	682	12	7200
G10-01	34	7/28/67	11	11	33	--	110	11	--	--	176	9	1300
G10-01	36	10/18/67	55		352	11	825	66	33	22	1364	24	200
G10-01	36	1/11/68	11		33		319	187	11		561	8	700

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M³	mg/M³
G12-01	0	5/03/67	22		88		154	88	--	220	572	8	4700
G12-01	0	7/28/67	--		33		44	--	11	44	132	4	2600
G12-01	0	10/18/67	66		616		924	--	--	66	1672	24	3200
G12-01	0	1/12/68	11		253		220	154	22	22	682	6	500
G12-01	21	5/03/67	--		110		308	22	--	154	594	12	5100
G12-01	29	7/28/67	6		23		66	--	6	17	118	6	1300
G12-01	20	10/18/67	220		1166		924	44	--	--	2354	32	2700
G12-01	20	1/12/68	22		99		99	110	11	11	352	5	1000
G12-01	40	5/03/67	44	--	--	--	330	88		44	506	9	3800
G12-01	40	7/28/67	--	--	110	11	187	--		--	308	7	2700
G12-01	36	10/18/67	55	44	539	11	517	22		11	1199	35	800
G12-01	38	1/12/68	33		154		231	176		11	605	9	600
G18-01	0	5/01/67	22	22	242		352	--	--	66	704	7	1400
G18-01	0	7/28/67	--	--	121		11	--	--	--	132	2	1200
G18-01	0	10/19/67	77	22	187		77	88	11	11	473	15	600
G18-01	0	1/13/68			132		143	22	44	55	396	7	500
G18-01	36	5/01/67	132		264		330	44	--	66	836	7	1100
G18-01	50	7/28/67	--		68		8	--	8	--	84	1	1800
G18-01	35	10/19/67	--		132		66	187	--	--	385	12	700
G18-01	36	1/13/68	11		88		132	110	33	33	407	6	200
G18-01	71	5/01/67	110		22		198	110	--	--	440	6	2800
G18-01	72	7/28/67	11		121		55	11	11	--	209	3	3500
G18-01	68	10/19/67			121		110	88	11	33	363	14	500
G18-01	70	1/13/68			110		77	33	11	33	264	11	200

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
H20-01	0	5/01/67	22	--	44	--	264	154	--	22	506	15	200
H20-01	0	7/28/67		22	132	66	--	11	22	33	286	4	2200
H20-01	0	10/19/67			110	11	22	418	11	88	660	13	500
H20-01	0												
H20-01	39	5/01/67	44		22	--	110	88	--	66	330	12	100
H20-01	54	7/28/67			154	--	--	--	11	--	165	2	1300
H20-01	39	10/19/67			165	11	22	759		11	968	15	400
H20-01													
H20-01	77	5/01/67	--		66		154	22		22	264	14	200
H20-01	79	7/28/67	--		44		--	11		--	55	7	3300
H20-01	74	10/19/67	66		154		88	1232		44	1584	16	800
H20-01													
123-01	0	5/01/67			22	--	528	132		110	792	12	200
123-01	0	7/29/67			22	121	--	22		77	242	6	1400
123-01	0	10/19/67			176		22	528		66	792	12	700
123-01	0												
123-01	40	5/01/67	88	88	220	--	418	132		132	1078	[illegible]	500
123-01	57	7/29/67	--	11	33	66	11	11		22	154	3	700
123-01	40	10/19/67	22		132	11	11	638		11	825	13	800
123-01													
123-01	78	5/01/67	66		44	--	198	44	--	66	418	15	200
123-01	80	7/29/67			22	121	--	33	11	--	187	3	1300
123-01	76	10/19/67			55		44	484	11	66	660	13	900
123-01													

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
J25-01	0	5/01/67		--	44	--	176	22		22	264	16	400
J25-01	0	7/29/67		11	66	55	55	66		55	308	5	1200
J25-01	0	10/20/67			88	11	49	99		11	258	10	1100
J25-01	0												
J25-01	38	5/01/67	22	22	22	--	198	66	--	66	396	10	100
J25-01	57	7/29/67	11		33	44	11	55	--	11	165	5	900
J25-01	39	10/20/67	22		99		55	132	22	44	374	13	1300
J25-01													
J25-01	75	5/01/67	22	--	44	--	176	154	--	44	440	10	400
J25-01	78	7/29/67	--	22	99	44	44	44	--	22	275	9	1300
J25-01	74	10/20/67	22		55	11	11	242	11	33	385	12	1400
J25-01													
K28-01	0	4/30/67	22	--	--	--	44	110		154	330	9	500
K28-01	0	7/29/67	33	33	154	33	--	--		--	253	3	400
K28-01	0	10/20/67			66	11	55	143		55	330	12	1000
K28-01	0												
K28-01	37	4/30/67	22	22	--	--	110	44		66	264	6	300
K28-01	57	7/29/67	11	11	154	11	33	22		--	242	1	300
K28-01	37	10/20/67	33		22		77	209		11	352	11	1500
K28-01													
K28-01	73	4/30/67	--	22	110	--	110	44		88	374	7	400
K28-01	74	7/29/67	11	11	55	11	55	66		--	209	3	100
K28-01	70	10/20/67	11		121		33	286		11	462	13	1200
K28-01													

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
L30-01	0	4/30/67	--	--	--	--	66	22		44	132	3	1700
L30-01	0	7/29/67	22	374	--	44	--	176		--	616	2	600
L30-01	0	10/20/67			88	11	11	165		11	286	11	600
L30-01	0												
L30-01	35	4/30/67	66		--	--	44	44	--	22	176	7	2100
L30-01	56	7/29/67	33		231	22	--	22	--	--	308	1	--
L30-01	36	10/20/67	11		88		22	220	33	66	440	9	600
L30-01													
L30-01	70	4/30/67	44		22	--	132	44		44	286	6	2400
L30-01	72	7/29/67			110	22	--	11		11	154	3	600
L30-01	68	10/20/67			110	11	33	330		22	506	11	400
L30-01													
L33-01	0	4/30/67	66	--	--	--	88	44	--	44	242	5	1500
L33-01	0	7/29/67	--	11	44	55	--	22	33	33	198	3	2200
L33-01	0	10/22/67	6		123		17	39	28		213	10	1900
L33-01	0												
L33-01	35	4/30/67	66	--	44	--	66	44	--	110	330	7	1400
L33-01	52	7/29/67	11	--	66	44	--	22	--	11	154	3	2300
L33-01	34	10/22/67	6	6	145		12	101	17	12	299	11	1700
L33-01													
L33-01	68	4/30/67	44	22	22	--	66	22	--	44	220	4	2200
L33-01	69	7/29/67		--	44	44	11	66	22	--	187	4	6200
L33-01	64	10/22/67		11	154		22	55	22	22	286	14	1500
L33-01													

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D.	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
L36-01	0	4/30/67	22	--	22	--	154	22	--	132	352	4	200
L36-01	0	7/29/67	11	33	66	121	22	--	--		253	2	1000
L36-01	0	10/22/67		22	242	11	11	66	22		374	10	1600
L36-01	0												
L36-01	35	4/30/67	--	44	--	--	154	22	--	110	330	7	200
L36-01	53	7/29/67	11	11	99	55	--	11	33	22	242	2	1700
L36-01	35	10/22/67			242	22	22	55	44	11	396	6	1200
L36-01													
L36-01	68	4/30/67	22		--	--	176	22	--	66	286	6	200
L36-01	67	7/29/67	11		44	77	22	22	11	--	187	1	1900
L36-01	66	10/22/67			231	33	11	55		11	341	7	1300
L36-01													
M38-01	0	4/30/67	44	--	88	--	132	44	--		308	6	1600
M38-01	0	7/30/67	968	506	154	--	--	88	--		1716	2	1100
M38-01	0	10/22/67	6		112	11	6	72	6		213	8	1000
M38-01	0												
M38-01	36	4/30/67	22	--	44	--	--	66		--	132	4	1300
M38-01	54	7/30/67	462	352	198	44	44	44		22	1166	2	1700
M38-01	31	10/22/67			85	22	6	34		12	159	6	1100
M38-01													
M38-01	72	4/30/67	22	--	22	--	66	66	--		176	7	1400
M38-01	72	7/30/67	132	66	198	66			132		594	2	1000
M38-01	59	10/22/67			77	33		231			341	6	4600
M38-01													

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TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
M41-01	0	4/30/67	44	--	22	--	132	132	--	22	352	5	1600
M41-01	0	7/30/67	550	1232	286	66	66	22	22		2244	2	1800
M41-01	0	10/22/67	33		121	11	11	33			209	7	1000
M41-01	0												
M41-01	58	4/30/67	--	--	88	--	176	--	--	22	286	3	800
M41-01	50	7/30/67	374	88	198	22		22	66		770	2	2200
M41-01	58	10/22/67	11		99	22		88			220	7	500
M41-01													
M41-01	114	4/30/67	--	--	--	--	132	22			154	5	2500
M41-01	112	7/30/67	220	66	22	22	--	--			330	1	2600
M41-01	112	10/22/67	11		56	17	11	55			150	4	1300
M41-01													
M43-01	0	4/30/67	--		--	--	198	22		--	220	4	100
M43-01	0	7/30/67	1870		154	--	44	--		--	2068	2	2000
M43-01	0	10/22/67			73	6		39		17	135	9	1000
M43-01	0												
M43-01	72	4/30/67	--	--	--	--	132	22	--	22	176	4	1200
M43-01	50	7/30/67	374	88	44	--	--	44	110	22	682	4	2000
M43-01	110	10/22/67			44	11	11	99	11	11	187	4	900
M43-01													
M43-01	142	4/30/67	66	--	22		66	66	--	22	242	4	1300
M43-01	138	7/30/67	198	44	22		--	--	66		330	1	2400
M43-01	136	10/22/67			33		44	33			110	3	1000
M43-01													

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M3	mg/M3
N45-01	0	4/29/67		--	--	--	44	22	--	66	132	3	800
N45-01	0	7/30/67		--	154	--	33	22	--	--	209	2	1100
N45-01	0	10/23/67		6	35	6	11	78	6	23	165	7	200
N45-01	0												
N45-01	80	4/29/67	66	--	44	--	22	66		22	220	3	500
N45-01	40	7/30/67	77	22	187	--	22	22		11	341	2	500
N45-01	120	10/23/67			23	11		17			51	4	200
N45-01													
N45-01	160	4/29/67	44		66		154	110		44	418	3	2100
N45-01	160	7/30/67	22		22		77	11			132	1	400
N45-01	154	10/23/67			12		6	22			40	3	400
N45-01													
047-01	0	4/29/67	--		--	--	88	22		--	110	0	200
047-01	0	7/30/67	22		132	33	11	33		22	253	3	2200
047-01	0	10/23/67			6	6		23		18	53	5	200
047-01	0												
047-01	79	4/29/67			--	--	88	22	--	22	132	3	100
047-01	55	7/30/67			54	30	8	8	120	--	220	2	2200
047-01	130	10/23/67			40	6	17	122	6	6	197	4	300
047-01													
047-01	157	4/29/67	22		22	--	22	22			88	3	200
047-01	175	7/30/67	--		--	--	--	--			--	1	2100
047-01	177	10/23/67	11		45	6	17	84			163	5	800
047-01													

TABLE 8 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
P49-01	0	4/29/67	44	--	154	--	330	132		--	660	5	100
P49-01	0	7/30/67	11	44	66	33	11	33		11	209	2	3000
P49-01	0	10/23/67	66		198			88		33	385	10	500
P49-01	0												
P49-01	49	4/29/67	44		66		374	154	--	66	704	7	500
P49-01	60	7/30/67	15		31		23	8	45	8	130	1	1800
P49-01	48	10/23/67			33			99		33	165	8	300
P49-01													
P49-01	96	4/29/67		--	66		110	44		44	264	7	300
P49-01	99	7/30/67		22	44		220	22			308	1	--
P49-01	92	10/23/67			17		11	122			150	7	600
P49-01													
Q51-01	0	4/29/67	154	--	66	--	419	88		66	793	10	500
Q51-01	0	7/30/67	23	8	46	15	8	--		15	115	2	800
Q51-01	0	10/23/67			56	11	6	77			150	7	400
Q51-01	0												
Q51-01	37	4/29/67	44		88	--	308	110		--	550	7	900
Q51-01	64	7/30/67			54	8	--	--		8	70	1	800
Q51-01	36	10/23/67			39		11	78		6	134	11	500
Q51-01													
Q51-01	72	4/29/67	44	22	132	--	110	110		22	440	7	400
Q51-01	74	7/30/67		--	31	--	23	--		--	54	1	--
Q51-01	69	10/23/67		6	233	6	17	127		6	185	7	300
Q51-01													

TABLE 8 (concluded)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE PLANKTON

			BLUE GREEN		GREEN		DIATOMS		FLAGELLATES		TOTAL	CHLORO	SESTON
STA. NO.	D	DATE	Coccoid	Filament	Coccoid	Filament	Centric	Pennate	Green	Brown	No/ml	mg/M^3	mg/M^3
R53-01	0	4/29/67	154	--	220	--	352	22	--	22	770	8	200
R53-01	0	7/30/67	33	33	66	22	11	--	--	11	176	2	900
R53-01	0	10/23/67			68		6	122	6	6	208	9	700
R53-01	0												
R53-01	32	4/29/67	176	--	154	--	418	66	--	--	814	9	200
R53-01	32	7/30/67	23	--	46	15	--	15	31	23	153	2	300
R53-01	31	10/23/67		6	80	22	34	166	17	6	331	9	900
R53-01													
R53-01	62	4/29/67	110		132	--	286	88	--	22	638	9	700
R53-01	62	7/30/67			11	16	--	--	11	22	60	2	1100
R53-01	59	10/23/67			91		6	161	6	6	270	8	400
R53-01													
S55-01	0	4/29/67	44		154		2002	154	--	110	2464	17	1100
S55-01	0	7/30/67	6		34		--	6	--	28	74	2	100
S55-01	0	10/23/67	6		50		11	133	6		206	14	400
S55-01	0												
S55-01	21	4/29/67	22	--	110	--	1914	242	--	132	2420	23	1100
S55-01	21	7/30/67	11	6	12	--	--	--	12	17	58	2	200
S55-01	21	10/23/67	11		73	12	6	220		6	328	13	200
S55-01													
S55-01	40	4/29/67	88	--	66	--	1870	484		22	2530	23	2400
S55-01	40	7/30/67	30	15	46	23	--	8		23	145	2	300
S55-01	38	10/23/67			45	6	11	123			185	12	200
S55-01													

TABLE 9

PERCENT PHYTOPLANKTON TYPES vs. TOTAL ORGANISMS
(Cleveland Program Office Data)

Basin	Spring	Summer	Fall	Winter	Annual
DIATOMS vs. TOTAL NUMBER OF ORGANISMS					
Western	87.0	47.4	52.9	85.8	66.9
Central	51.7	14.7	56.3	60.6*	46.5
Eastern	76.9	9.1	56.1		52.5
BLUE-GREENS vs. TOTAL NUMBER OF ORGANISMS					
Western	4.0	20.8	8.8	1.8	8.4
Central	19.8	32.8	2.4	3.0*	14.5
Eastern	7.6	60.6	3.8		23.7
GREENS vs. TOTAL NUMBER OF ORGANISMS					
Western	6.9	26.8	36.9	10.2	22.6
Central	17.4	42.2	35.7	27.5*	30.2
Eastern	10.7	22.7	34.7		18.1
FLAGELLATES vs. TOTAL NUMBER OF ORGANISMS					
Western	2.1	5.0	1.4	2.2	2.3
Central	11.1	10.3	5.5	8.9*	8.8
Eastern	4.8	7.6	5.4		5.8

* 3 stations sampled out of total of 11 stations

TABLE 10

AVERAGE PHYTOPLANKTON POPULATIONS
Organisms per ml
(Cleveland Program Office Data)

Type of Algae	Season	Basin Western	 Central	 Eastern
Diatom	Spring	1943	238	500
Blue-Green	Spring	91	91	50
Green	Spring	152	81	70
Flagellate	Spring	47	51	31
Total	Spring	2233	461	651
Diatom	Summer	468	45	35
Blue-Green	Summer	207	101	230
Green	Summer	265	137	86
Flagellate	Summer	52	32	29
Total	Summer	992	315	380
Diatom	Fall	1378	284	102
Blue-Green	Fall	229	12	7
Green	Fall	960	180	63
Flagellate	Fall	36	28	10
Total	Fall	2603	504	182
Diatom	Winter	514	391*	--
Blue-Green	Winter	11	20*	--
Green	Winter	61	177*	--
Flagellate	Winter	16	58*	--
Total	Winter	602	646*	--

* 3 station average

TABLE II

WATER BIOLOGY COMPARISONS
Average numbers of Organisms per ml
(Cleveland Program Office Data)

Season		Basin		
		Western	Central	Eastern
Spring	1963-64	1805	1170	575
	1967-68	2233	461	651
Fall	1963-64	10,800	1005	180
	1967-68	2603	504	182

CHLOROPHYLL AND SESTON

To supplement phytoplankton data chlorophyll and seston analyses were instituted for the Cleveland Program Office 1967-68 study, (see Table 8). Chlorophyll is an enzyme present in green plants. In the presence of light, through photosynthesis, chlorophyll converts water and carbon dioxide to sugar, a substance basic to plant metabolism and reproduction. As a result chlorophyll is closely related to primary production or the conversion of inorganic materials to living plant tissue. Chlorophyll determinations are used to give an estimate of phytoplankton productivity since the amount of chlorophyll present is an indicator of the type algae present. Coccoid and filamentous green algae contain chlorophyll a and b. Diatoms and brown flagellates contain chlorophyll a and c but lack chlorophyll b. Blue-green algae contain only chlorophyll a.

Organic seston includes the living phytoplankton and zooplankton, and the non-living particles of organic matter floating or held in suspension in the water. It provides a gross estimate of algal productivity by assuming that most of the mid-Lake Erie suspended organic matter is derived from algal sources. However, in some instances this may not be true, and significant contamination with non-living organic debris (tripton) is a probability. The results of Lake Erie 1967-68 chlorophyll and seston determinations are summarized in Table 8.

SEDIMENT BIOLOGY

Benthic fauna are macroscopic organisms which live on or within lake bottom sediments. Some have been classified, rather nonprecisely, as "pollution-tolerant" or "pollution-sensitive". Characteristic of a clean water zone is the presence of many kinds of bottom organisms. Typical clean water species are immature caddis flies (Tricoptera), stoneflies (Plecoptera), mayflies (Ephemeroptera), dobson flies (Megaloptera), gill-breathing snails (Prosobranchia), scuds (Amphipoda) and pearl button clams (Unionidae). Although the variety of organisms is great, the total population is small, because of predation and competition for food.

In a polluted zone only a few kinds of organisms can survive in the soft, shifting, bottom organic sludge blanket. Such organisms, isolated from predators, reproduce to huge populations. These include sludgeworms (Oligochaetea), some kinds of bloodworms (Chironomidae), sowbugs (Isopoda), lung-breathing snails (Pulmonata), various leeches (Hirudinea) and the fingernail clam (Sphaeriidae).

The results of bottom fauna surveys of Lake Erie in 1967-68 by the Cleveland Program Office are summarized in Table 12. The pollution-sensitive scud is found only in small numbers in the western basin, increasing in quantity in the central basin, and reaching a high in the west end of the eastern basin, only to decrease sharply in the extreme east portion of the lake. The more pollution-tolerant sludgeworms, bloodworms, fingernail clams and nematodes are prevalent throughout the entire lake.

WATER BACTERIOLOGY

Bacterial densities in Lake Erie under ice cover have never been determined on a lake-wide basis. Towards this end, samples were collected at two depths (top and bottom) in January 1968 for the following parameters: Standard Plate Count, 20°C, Standard Plate Count, 35°C, and total coliforms. As mentioned previously, this cruise was only completed in the western basin with partial sampling in the central basin. The results are summarized in Table 13.

Under ice conditions rather large bacterial populations were found in western basin bottom waters. In 1963-64 during non-winter sampling, larger bacterial populations were found in western basin surface waters. The three stations sampled in winter in the central basin were for all practical purposes free of coliform organisms. In the western basin the sampling stations closest to Toledo and Detroit demonstrated the highest bacterial densities. Coliforms ranged from a high of 1,350 per 100 ml to less than one per 100 ml.

TABLE 12

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE BENTHIC MACROINVERTEBRATES

STA. NO.	D	DATE	Am	Is	Pr	Pu	Hi	Ol	Ne	Tu	Un	Sp	Ch	Ep	Tr	Ot	TOTAL
D09-01	44	5/03/67		--	--			1340	82			33	409				1864
D09-01	64	7/28/67		38	5			485	5			5	98				636
D09-01	46	10/18/67						605	87			11	87				790
D09-01																	
D13-01	46	5/02/67		--				387	87			202	354			125	1155
D13-01	49	7/28/67		--				87	142			65	82				376
D13-01	46	10/18/67		38				1384	229			512	305				2468
D13-01	47	1/12/68		16	60			1705	120			512	245				2658
E02-01	28	5/04/67	--				6	447	327				--				780
E02-01	31	7/26/67	--				--	3272					387				3659
E02-01	34	10/16/67	11				65	9286					97				9459
E02-01	32	1/09/68	5				16	768					44				833
E05-01	24	5/04/67	27		--		22	501	55			142	1199				1946
E05-01	26	7/26/67			--		16	578	71			38	349				1052
E05-01	25	10/17/67			--		16	4289				158	615				5737
E05-01	26	1/10/68			5		11	686	131			65	300				1198
F03-01	33	5/04/67	x				x	x	--	--		x	--				--
F03-01	34	7/26/67					990	13,302	--	--		1635	--				15,927
F03-01	32	10/16/67					118	7371	54	11		742	721				9017
F03-01	33	1/10/68					16	474		49			32				571
F03-02	26	5/04/67	--		--		6	878	--			87	452				1423
F03-02	25	7/27/67	--		--		--	1570	22			87	103				1782
F03-02	25	10/17/67	33		5		42	2360	65			174	262				2941
F03-02	32	1/09/68					10	2638				11	60				2719

TABLE 12 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE BENTHIC MACROINVERTEBRATES

STA. NO.	D	DATE	Am	Is	Pr	Pu	Hi	Ol	Ne	Tu	Un	Sp	Ch	Ep	Tr	Ot	TOTAL
F16-01	61	5/02/67						311	507			392	136			11	1357
F16-01	62	7/28/67						114	136			71	33				354
F16-01	60	10/18/67						425	283			1994	98				2800
F16-01	63	1/13/68						436	529			954	76				1995
G04-01	28	5/4/67	--		38		66	229	--		--	38	49		--	--	420
G04-01	30	7/27/67	87		82		54	687	5		--	371	289		5	--	1580
G04-01	30.5	10/17/67	16		--		156	4959	5		5	153	38		--	--	5332
G04-01	29	1/09/68			16		147	8486	5		5	82	365		--	27	
G06-01	32	5/04/67	--		11	--	11	109	49		--	16	164				360
G06-01	34	7/27/67	--		16	--	21	64	--		10	103	114				328
G06-01	32	10/17/67	5		--	92	48	2305	93		5	120	93				2761
G06-01	32	1/10/68	109		142	5	38	2807	16		16	272	114			141	3660
G07-01	49	5/03/67	--		--		--	452	--		--	49	164				665
G07-01	36	7/27/67	--		11		5	561	441		5	169	567				1759
G07-01	34	10/17/67	16				5	1760	289		5	120	185				2380
G07-01	35	1/10/68						1330	251			16	33				1630
G09-01	37	5/03/67	--		6		11	403	262		--	71	202				955
G09-01	36	7/27/67	--		5			256	76		10	71	283				701
G09-01	36	10/17/67	11		5			828	480		5	245	153				1727
G09-01	38	1/11/68			16		22	665	238			121	142			16	1230
G10-01	38	5/03/67	--	--	--		60	409	--		--	--	153				622
G10-01	36	7/28/67	16	16	--		11	638	16		10	22	223				952
G10-01	40	10/18/67	--	--	--		37	289	32		5	44	71				478
G10-01	39	1/11/68	60	33	16		125	2180	103		10	131	387			5	3020

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TABLE 12 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE BENTHIC MACROINVERTEBRATES

STA. NO.	D	DATE	Am	Is	Pr	Pu	Hi	Ol	Ne	Tu	Un	Sp	Ch	Ep	Tr	Ot	TOTAL
G12-01	42	5/03/67	No sample		--		--	--	--		--	--	--			--	--
G12-01	42	7/28/67	x	x	--		x	x	x		--	x	x			--	x
G12-01	40	10/18/67	x	x	x		x	x	x		x	x	x			x	x
G12-01	41	1/12/68			x		x	x	x			x	x				x
G18-01	73	5/01/67						196	540			349	87				1172
G18-01	74	7/28/67						44	131			109	5				289
G18-01	72	10/19/67						163	234			54	98				549
G18-01	73	1/13/68						1635	365			245	76				2321
H20-01	79	5/01/67						692	289			115	109			27	1232
H20-01	81	7/28/67						507	163			245	11				926
H20-01	78	10/19/67						403	71			114					588
H20-01																	
I23-01	80	5/01/67	--	22				349	273			360	16			11	5031
I23-01	82	7/29/67	--	54				153	817			120					1144
I23-01	80	10/19/67	11	49				305	49			512					926
I23-01																	
J25-01	77	5/01/67		71	--			398	98			191	27			--	785
J25-01	80	7/29/67		--	981			5559	234			229	11			5	7019
J25-01	78	10/20/67		11				305	49			125	5				495
J25-01																	
K28-01	75	4/30/67		207	--			839	158			93	65				1362
K28-01	76	7/29/67		180	5			463	142			872	5				1667
K28-01	74	10/20/67			10			583	44			49					686
K28-01																	

TABLE 12 (continued)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE BENTHIC MACROINVERTEBRATES

STA. NO.	D	DATE	Am	Is	Pr	Pu	Hi	Ol	Ne	Tu	Un	Sp	Ch	Ep	Tr	Ot	TOTAL
L30-01	72	4/30/67		109	38		109	1384	768			845	196			6	3455
L30-01	74	7/29/67		60	49		120	1308	349			191	71				2148
L30-01	72	10/20/67		240	5		11	1488	589			474					2807
L30-01																	
L33-01	70	4/30/67	16	174	6		33	567	360			153	180			33	1525
L33-01	71	7/29/67	x	x	x		x	x	x			x	x			x	
L33-01	68	10/22/67		365			38	3036	311			518	142				4410
L33-01																	
L36-01	70	4/30/67	x	x			--	x	--				x		--	--	x
L36-01	69	7/29/67	x	--			x	x	--				--		x	x	x
L36-01	70	10/22/67		x				x	x				x				x
L36-01																	
M38-01	74	4/30/67	1433	--	49	6		262	741			333	131		--		2955
M38-01	74	7/30/67	3554	16	--	5		1237	381			--	5		5		5203
M38-01	63	10/22/67	676	27	5			632	11			807	76		5		2239
M38-01																	
M41-01	116	4/30/67	4676	--				242	365			71	414				5768
M41-01	114	7/30/67	4502	11				2365	1090			240	196				8404
M41-01	116	10/22/67	3526	5				1019	316			109					4975
M41-01																	
M43-01	144	4/30/67	845					278	120			11	6				1260
M43-01	140	7/30/67	1112					779	185			--	11				2087
M43-01	140	10/22/67	698					1401	371			27	5				2502
M43-01																	

TABLE 12 (concluded)

CLEVELAND PROGRAM OFFICE
LAKE ERIE ROUTINE SURVEILLANCE
MID-LAKE BENTHIC MACROINVERTEBRATES

STA, No.	D	DATE	Am	Is	Pr	Pu	Hi	Ol	Ne	Tu	Un	Sp	Ch	Ep	Tr	Ot	TOTAL
N45-01	162	4/29/67	1183					480	153			11	76				1903
N45-01	164	7/30/67	774					365	98			16	16				1269
N45-01	158	10/23/67	543					2376	49			11					2979
N45-01																	
047-01	159	4/29/67	--	--				2998				--	--				2998
047-01	178	7/30/67	185	11				1537				--	--				1733
047-01	182	10/23/67		16				2572				11	11				2610
047-01																	
P49-01	98	4/29/67	8993	229				185	11			109	818				10345
P49-01	101	7/30/67	866	196				1428				147	33				2670
P49-01	96	10/23/67	670	44				861				125	5				1705
P49-01																	
Q51-01	74	4/29/67	16	224	--		33	398	327			104	1417			6	2525
Q51-01	76	7/30/67	147	103	5		27	218	--			196	550				2254
Q51-01	73	10/23/67	65	583			16	1068	49			243					2015
Q51-01																	
R53-01	64	4/29/67	65	16	121	12	44	578	202			240	736				2014
R53-01	64	7/30/67	60	38	11		11	1128	360			218	283				2109
R53-01	62.5	10/23/67	22		5		125	2720	158			98	480				3608
R53-01																	
S55-01	42	4/29/67	6		--	11	--	632	65			251	278				1245
S55-01		7/30/67	--		--	--	--	--	--			--	--				--
S55-01	42	10/23/67	93		5	22	33	1629	87			234	899				3002

TABLE 13

LAKE ERIE WATER MICROBIOLOGY
WINTER (68) CRUISE
(Cleveland Program Office Data)

Sampling Point		Date	Total Coliforms per 100 ml water sample	Standard Plate Count per ml water sample at 20°C	Standard Plate Count per ml water sample at 35°C
E2-1	Top	1/9/68	380	2,000	1,200
E2-1	Bottom		1,240	2,500	2,800
F3-1	Top	1/9/68	700	1,100	470
F3-1	Bottom		350	1,600	270
F3-2	Top	1/9/68	20	1,000	350
F3-2	Bottom		33	1,200	220
G4-1	Top	1/9/68	30	2,600	360
G4-1	Bottom		110	2,000	480
E5-1	Top	1/10/68	<1	290	75
E5-1	Bottom		11	1,300	54
G6-1	Top	1/10/68	60	2,000	280
G6-1	Bottom		1,350	2,100	420
G7-1	Top	1/10/68	450	2,200	360
G7-1	Bottom		97	2,800	200
G9-1	Top	1/11/68	120	900	480
G9-1	Bottom		140	870	320
G10-1	Top	1/11/68	38	130	140
G10-1	Bottom		4	300	180
G12-1	Top	1/12/68	4	29	1
G12-1	Bottom		2	48	6
D13-1	Top	1/12/68	<1	35	3
D13-1	Bottom		2	140	31
F16-1	Top	1/13/68	<1	31	7
F16-1	Bottom		<1	43	2
G18-1	Top	1/13/68	<1	16	3
G18-1	Bottom		<1	3	7

discharged into the lake, so that when we sampled in 1963 we essentially sampled under different conditions than you would be sampling today. You cannot make the conditions the same.

CHAIRMAN STEIN: Well, when can you ever do that?

MR. HARLOW: You can't; you can't.

CHAIRMAN STEIN: In other words, this is as good a comparison as we could ever hope for.

MR. HARLOW: That is true.

CHAIRMAN STEIN: Isn't that what we always do in pollution control? We take the river one year and we take the river the next, and I don't know that we ever find the same river.

All right. Are there any further comments or questions?

MR. OEMING: Yes, I have a couple, Mr. Chairman.

Mr. Harlow, on the bottom of the first page you mention that there is a decrease in silica and this is accompanied by an increase in diatom populations.

Now, you don't draw any further conclusion about this. Are you prepared to draw some conclusion? Is this good or is this bad? I mean the increase in diatom population. Have we substituted one problem for another?

MR. HARLOW: I don't know whether there is a relationship there or not between the fact that the silica has gone down and the diatoms have gone up.

MR. OEMING: Let's take the diatoms themselves. Is this bad?

MR. HARLOW: Yes, the diatom is an algae and it goes to the problem of eutrophication and overenrichment of the lake, and that is all a part of the algal population, and I think we are trying to keep that to a minimum. But I don't think it is the silica necessarily that has caused the diatoms to increase; that is not what I am saying.

MR. OEMING: Now, you didn't have anything to say here about the depressed area in the central portion of the lake that was found prior to the initiation of this conference. Did you study that area again this last year to determine whether it has expanded or decreased or what?

MR. HARLOW: Yes, we did study it, and it so happens that when we went through the lake with our surveillance program, in cooperation with the Coast Guard last summer, it was in July, and we were just in the beginning of the decreasing oxygen values in the central basin bottom waters. On the basis of our sampling, it is difficult to draw conclusions, but it looked to me, from the day that we had, that the area of oxygen depletion was increasing. However, we did not sample during the severest period of oxygen depletion which usually occurs the last of August.

MR. OEMING: Do you plan to do that this year?

MR. HARLOW: This year we are changing our surveillance program slightly so that instead of doing one in the winter, spring, summer and fall, like we did last year, we are going to concentrate on the mid-lake during late summer to try to define better that area of oxygen depletion and be able to make comparisons on that basis with earlier data.

MR. OEMING: I think that needs to be done. I am glad you are thinking about that, because that is one of the primary concerns in this lake aside from the nutrients themselves, but this decreased oxygen area -- is it getting bigger or is it constant, or what is happening to it? We don't know much about it since the original study.

MR. HARLOW: It is still there, but I can't say categorically that it is increased or decreased.

MR. OEMING: I see.

CHAIRMAN STEIN: All right. Mr. Metzler.

MR. METZLER: I am interested with your observation that the nitrates have not increased. So do I take it from that they are actually decreased in the central and eastern portions of the basin?

MR. HARLOW: In the middle of my statement on the first page, talking about "In the central basin for the same period, all chemical constituents have increased except chlorides, silica and nitrates" -- that means that nitrates have decreased

MR. METZLER: Now, isn't that a pretty significant finding? Here is one of the two minimum nutrients that we are concerned about. Do you have some explanation for why the nitrates might have decreased?

MR. HARLOW: No, I haven't looked into the data, quite frankly, with that perspective. I am not so sure total N has decreased. I think it has increased.

By the way, very deep in that surveillance report that I handed out are individual summaries of every basin and every constituent. We have figures, I think, for the entire lake -- an average for the entire lake -- and I think an average for each sub-basin: eastern, western and central basins, on the increase or decrease of each constituent.

I may be wrong on this, but we can dig it out of the data. I think total N has increased.

MR. METZLER: If total N has increased, you mean it is in the form of ammonia or some other form than nitrates, is that what you are saying?

MR. HARLOW: I expect it might be organic, but still I am not sure. We have to look in the detailed data to find this out for sure.

MR. METZLER: I think that is a very interesting observation that ought to be followed through certainly.

CHAIRMAN STEIN: Are there any other comments or questions?

MR. HARLOW: I am handing out to the conferees a report on bathing beach water quality in Lake Erie.

At the June 1, 1967 meeting of the Lake Erie Enforcement Conferees, the five basin States and the Federal Water Pollution Control Administration requested a report on the conditions of bathing beaches in Lake Erie.

In reply to this request, this report was prepared for presentation at this meeting.

The contents of the report are based on information ascertained from local, State and Federal agencies. Evaluations were not made of Michigan beaches located on the Detroit River, Lake St. Clair and St. Clair River or beaches not open to the public.

Sixty beaches are summarised with the following conclusions:

Three beaches are considered unquestionably acceptable for swimming. They are Cedar Point in Ohio, Presque Isle State Park in Pennsylvania and Beaver Island State Park in New York.

Twenty-six beaches are considered generally acceptable for swimming. These beaches sometimes exceed acceptable swimming limits for short periods particularly during and immediately after heavy rains or strong winds.

Eleven beaches are considered of questionable water quality which indicates frequent pollution problems.

Eleven beaches are considered unacceptable for swimming.

The remaining nine beaches do not have sufficient data to evaluate their water quality.

Pollution sources to Lake Erie beaches include sewer overflows, municipal treatment plant bypasses, inadequately disinfected effluents, septic tank discharges, urban and rural runoff and industrial waste discharges. These sources not only contribute bacterial pollution but also are causes of nuisance conditions. Many beaches have severe algal problems where obnoxious and unsightly conditions are present from decaying algae. Beaches that are generally acceptable are in some cases encumbered by decomposing algae and dead fish which, without adequate maintenance, become undesirable.

Color, oil, garbage, trash and other debris add to the physical degradation of the beaches which impair recreational activity.

These problems of Lake Erie beaches are curable. With adequate monitoring programs which include intensive sanitary surveys, the extent of problems can be adequately defined. These problems are highly publicized and are numerous. Such problems, which need immediate attention if the beach situation is to be improved, are adequate disinfection of effluents, the sewering of areas which are presently served by spetic tanks in undesriable soils, diversion and chlorination of stormwater outfalls and combined sewer overflows, and regulation of bypass structures to convey the maximum flow to treatment plants.

This program is essentially what the conferees recommended in 1965. In addition, in order to make the beaches more attractive, increased beach maintenance programs are essential.

This completes my statement on the beach programs.

CHAIRMAN STEIN: Without objection, this entire report will appear in the record as if read.

(Reports entitled "Lake Erie Bathing Beach Water Quality" and "Lake Erie Environmental Summary 1963-1964" follow.)

LAKE ERIE
BATHING BEACH WATER QUALITY

JUNE 1968

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SUMMARY

At the June 1, 1967 meeting of the Lake Erie Enforcement Conferees, the five basin states and the Federal Water Pollution Control Administration requested a report on the conditions of bathing beaches in Lake Erie.

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>
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>
> Eleven beaches are considered of questionable water quality which indicates frequent pollution problems.
>
> Eleven beaches are considered unacceptable for swimming.
>
> The remaining nine beaches do not have sufficient data to evaluate their water quality.

The following table summarizes these beaches by state:

LAKE ERIE BATHING BEACH SURVEY WATER QUALITY CONDITIONS BY STATE

	Safe	Generally Safe Slight Pollution	Questionable Moderate Pollution	Unsafe	Insufficient Data
Michigan	-	4	1	-	-
Ohio	1	17	3	8	8
Pennsylvania	1*	-	1	-	1
New York	1	5	6	3	-

* Does not include Beach #1 which is generally safe and Beach #11 which is questionable.

Pollution sources to Lake Erie beaches include sewer overflows, municipal treatment plant bypasses, inadequately disinfected effluents, septic tank discharges, urban and rural runoff, and industrial waste discharges. These sources not only contribute bacterial pollution but also are causes of nuisance conditions. Many beaches have severe algal problems where obnoxious and unsightly conditions are present from decaying algae. Beaches that are generally acceptable are in some cases encumbered by decomposing algae and dead fish which, without adequate maintenance, become undesirable.

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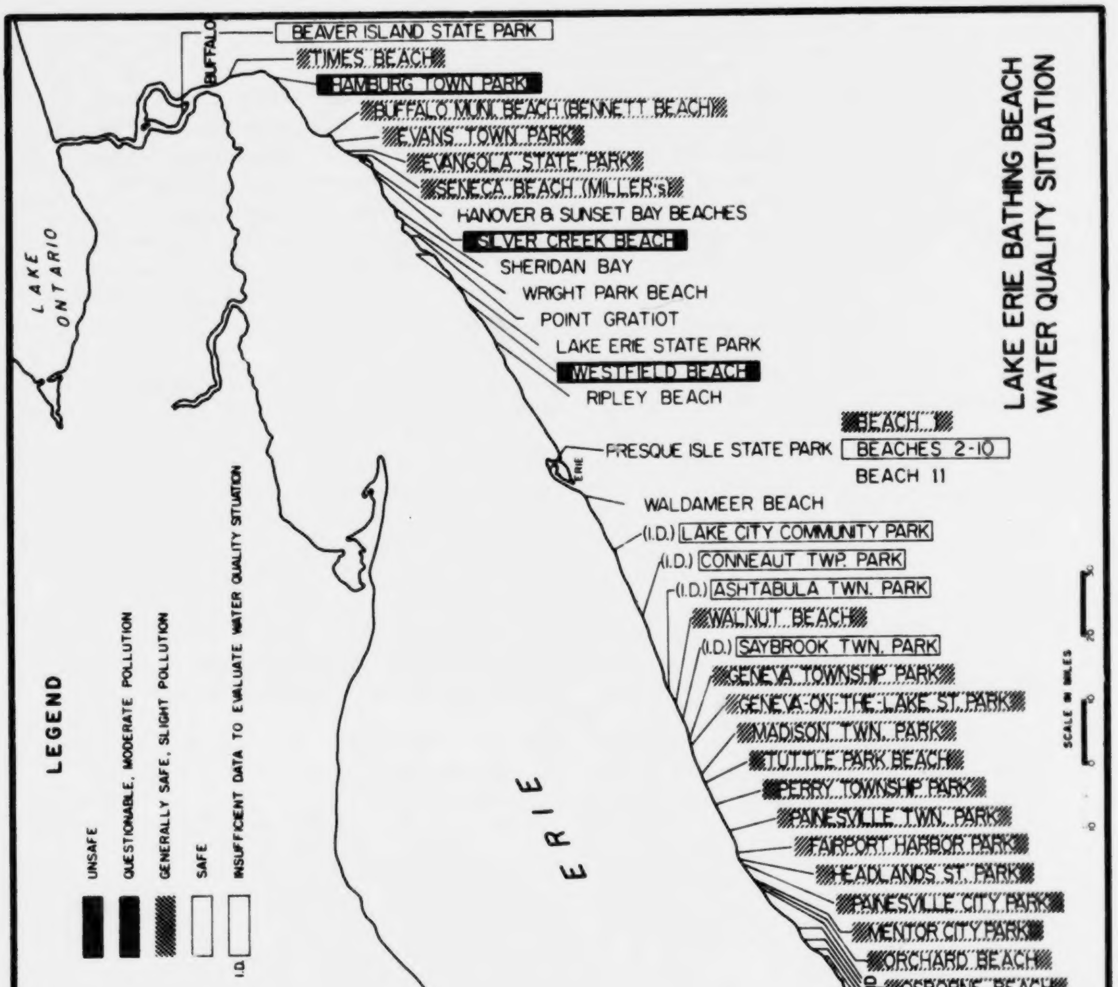
These problems of Lake Erie beaches are curable. With adequate monitoring programs which include intensive sanitary surveys, the extent of problems can be adequately defined. These problems are highly publicized and are numerous. Such problems, which need immediate attention if the beach situation is to be improved, are adequate disinfection of effluents, the sewering of areas which are presently served by septic tanks in undesirable soils, diversion and chlorination of storm water outfalls and combined sewer overflows and regulation of bypass structures to convey the maximum flow to treatment plants.

This program is essentially what the Conferees recommended in 1965. In addition, in order to make the beaches more attractive, increased beach maintenance programs are essential.


BUFFALO
BEAVER ISLAND STATE PARK
TIMES BEACH
HAMBURG TOWN PARK
BUFFALO MUNI. BEACH (BENNETT BEACH)
EVANS TOWN PARK
EVANGOLA STATE PARK
SENECA BEACH (MILLER's)
HANOVER & SUNSET BAY BEACHES
SILVER CREEK BEACH
SHERIDAN BAY
WRIGHT PARK BEACH
POINT GRATIOT
LAKE ERIE STATE PARK
WESTFIELD BEACH
RIPLEY BEACH
LAKE ONTARIO
ERIE
PRESQUE ISLE STATE PARK
BEACH 1
BEACHES 2-10
BEACH 11
WALDAMEER BEACH
(I.D.) LAKE CITY COMMUNITY PARK
(I.D.) CONNEAUT TWP. PARK
(I.D.) ASHTABULA TWN. PARK
WALNUT BEACH
(I.D.) SAYBROOK TWN. PARK
GENEVA TOWNSHIP PARK
GENEVA-ON-THE-LAKE ST. PARK
MADISON TWN. PARK
TUTTLE PARK BEACH
PERRY TOWNSHIP PARK
PAINESVILLE TWN. PARK
FAIRPORT HARBOR PARK
HEADLANDS ST. PARK
PAINESVILLE CITY PARK
MENTOR CITY PARK
ORCHARD BEACH
OSBORNE BEACH
CLEVELAND
LLOYD RD. PARK
EUCLID PARK
WILDWOOD PARK
WHITE CITY PARK
EDGEWATER PARK
PERKINS BEACH
ROCKY RIVER PK.
HUNTINGTON PARK
AVON LAKE PARK
SHEFFIELD PARK
CENTURY PARK
LAKE VIEW PARK
(I.D.) VERMILION PARK
(I.D.) HURON CITY PK.
CEDAR POINT
(I.D.) KELLEYS IS. ST. PK.
EAST HARBOR ST. PK.
(I.D.) PORT CLINTON PK.
(I.D.) SO. BASS IS. ST. PK.
CRANE CREEK ST. PARK
TOLEDO AREA BEACHES
TOLEDO
DETROIT
LAKE ST CLAIR
LAKE HURON
POINTE AUX PEAUX
STONY POINT PARK
WILLOW BEACH
STERLING STATE PARK
TOLEDO BEACH
LAKE ERIE
LEGEND
■ UNSAFE
■ QUESTIONABLE, MODERATE POLLUTION
▨ GENERALLY SAFE, SLIGHT POLLUTION
☐ SAFE
I.D. ☐ INSUFFICIENT DATA TO EVALUATE WATER QUALITY SITUATION
SCALE IN MILES
0
10
20
30

LAKE ERIE BATHING BEACH WATER QUALITY SITUATION

265-

Many state, local and private beaches dot the Lake Erie shoreline. These beaches vary considerably in both size and attendance. Many of these beaches are not being used to their full potential. Although geographical location in relation to population centers is a factor which limits use, an unfortunate but major factor in reducing attendance at some beaches is pollution.

Bacterial pollution, or esthetic impairment, is a problem in almost all areas. Even beaches with good to excellent water quality at least occasionally have esthetic problems from algae and dead fish. With inadequate beach maintenance programs, this situation produces obnoxious and unsightly nuisance conditions. Dead fish, which may have died from natural causes, are immediately associated by bathers with pollution.

Excess nutrients in Lake Erie have contributed greatly to extensive increases in algal production in all areas of Lake Erie, particularly from the island chain west and the far eastern portion of the lake.

Additional esthetic problems such as color, oil, garbage, trash and other debris add to the physical degradation of the beaches, further impairing recreational activity.

From a public health standpoint, of far more important concern is the bacterial quality of the water. Beaches have become bacterially polluted from storm water outfalls, combined sewer overflows, inadequately disinfected wastes from municipal treatment plants, septic tank discharges, industrial waste discharges and urban and rural runoffs.

The extent of bacterial pollution at beaches depends on location of bathing areas in relation to pollution sources. There are very few beaches which are not at least occasionally affected by bacterial pollution. A number of beaches are adversely affected only periodically, such as during and immediately after rains and strong winds. Unfortunately, many beaches are frequently or continuously contaminated by bacterial pollution.

Some beaches which are unsafe for swimming have been posted as such by the state or local health departments, but the public still insists on swimming in these areas. This is due probably to an unawareness on the part of the bathers as to the health hazard present.

This report summarizes the water quality situation of beaches both esthetically and bacterially. Many private community beaches and small public beaches are not included in this report but should not be ignored in the development of adequate monitoring programs.

The evaluations in this report are based on information from local, state and federal agencies. The four classifications for evaluations are as follows:

1. Safe - Beaches with good to excellent water quality with infrequent water quality problems.
2. Generally safe, slight pollution - Although beaches may be safe for swimming, there are occurrences when beaches should be temporarily posted against swimming.
3. Questionable, moderate pollution - Beaches with questionable water quality; further studies may indicate frequent posting against swimming.
4. Unsafe - Beaches unsafe for swimming as indicated by excessively high coliform counts; should be posted against swimming until analyses indicate acceptable water quality.

MICHIGAN

Figure 1 summarizes the bacterial data collected by the Michigan Water Resources Commission and the Monroe County Health Department. Although the median coliform concentrations are generally below the recommended safe limit for swimming, the maximum concentrations are very high and indicate that pollution reaches these beaches.

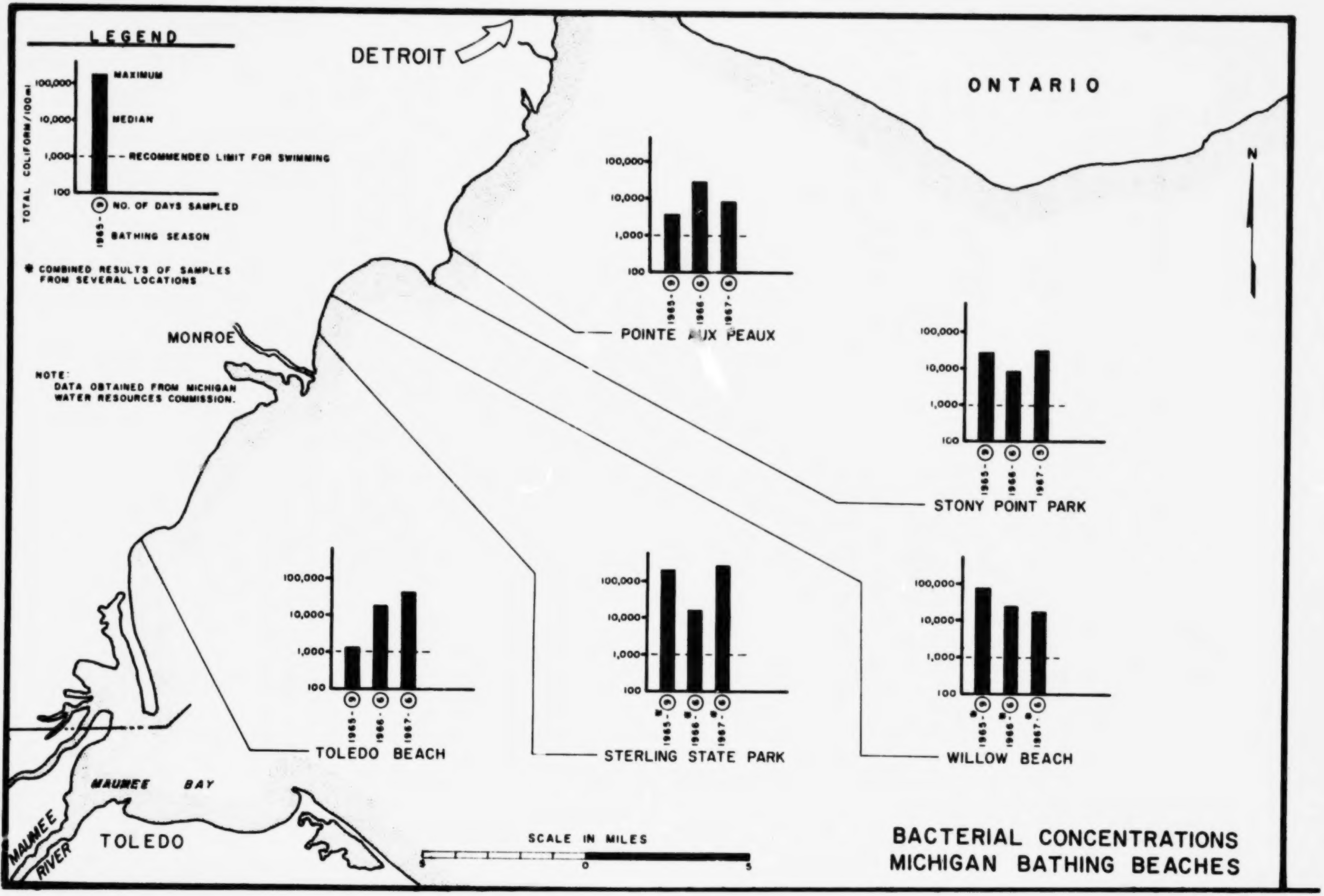
The principal sources of pollution are combined sewer overflows, municipal waste discharges, industrial wastes, and storm water outfalls discharging in or near beach areas. The municipal wastes are primarily from Detroit, Wyandotte, Riverview, Trenton, Monroe and some built up inland communities. Michigan beaches, especially the ones closer to the Detroit River, are adversely affected during winds from the north or east. Bacterial concentrations increase greatly at this time as does the accumulation of decaying algae and debris.

Sterling State Park and Willow Beach have good sand beaches but out in the water the bottom contains a considerable amount of muck. Both are plagued by algae. Sterling State Park has been posted as unsafe for swimming by the Michigan Department of Public Health but many people still swim there in spite of the warning signs.

Sterling State Park pollution stems from three sources: (1) wastes from Consolidated Paper Company, Monroe Paper Products Company, and Union Bag Camp Paper Company in Monroe, (2) the City of Monroe's municipal wastes, and (3) septic tank drainage from the unsewered Brest Bay communities.

OHIO

The Ohio beaches vary in water quality from quite good to grossly polluted. Figures 2, 3 and 4 summarize bacterial data as reported by the local health departments.


LEGEND
TOTAL COLIFORM/100ml
100,000
10,000
1,000
100
MAXIMUM
MEDIAN
RECOMMENDED LIMIT FOR SWIMMING
NO. OF DAYS SAMPLED
1965 - BATHING SEASON
* COMBINED RESULTS OF SAMPLES FROM SEVERAL LOCATIONS
DETROIT
ONTARIO
N
MONROE
NOTE: DATA OBTAINED FROM MICHIGAN WATER RESOURCES COMMISSION.
POINTE AUX PEAUX
STONY POINT PARK
TOLEDO BEACH
STERLING STATE PARK
WILLOW BEACH
1965
1966
1967
MAUMEE BAY
MAUMEE RIVER
TOLEDO
SCALE IN MILES
5
0
5

BACTERIAL CONCENTRATIONS
MICHIGAN BATHING BEACHES

FIGURE 1

Toledo to Avon Lake

The beaches in this area outside of the large pollution areas are probably of fairly good water quality. Adequate data on most beaches in this area (Figure 2) are not available, so conclusive evaluations of these beaches are not possible. However, during rainfall these beaches can be adversely affected by combined sewer overflows, storm water discharges, sewage treatment plant bypasses, and land runoff.

Beaches between Toledo and Sandusky are subjected to periodic fouling from accumulations of rotting algae and aquatic plants. Due to the rocky substrate in much of the area, attached algae are better able to grow. Algae problems are very prevalent in the island area.

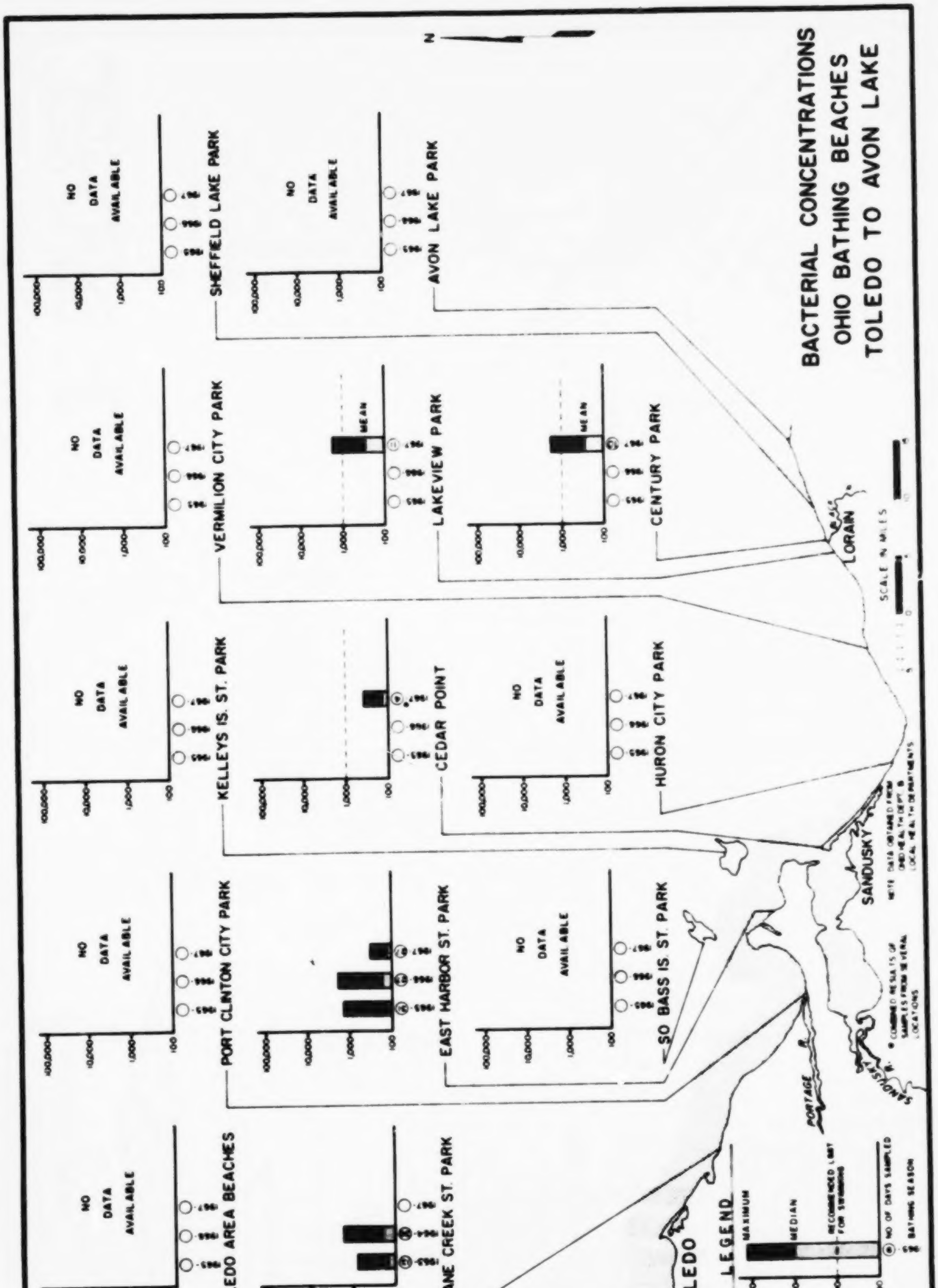
The beaches in the Toledo area are polluted by the Maumee River (including the Toledo treatment plant effluent), storm and combined sewer overflows and bypasses from the Toledo treatment plant. The Lucas County Health Department does not recommend swimming at any beach in the county except Crane Creek State Park.

The principal sources of pollution in the Lorain-Avon Lake Area are storm and combined sewer overflows, bypasses from sewage treatment plants, and the Black River. The Lorain County Health Department discontinued their sampling program at Avon Lake and Sheffield Lake in 1964 after the results of their study showed continual polluted conditions. Century and Lakeview Parks in Lorain have had high counts in the past and the City Health Department has recommended against swimming in either of these beaches.

Greater Cleveland (Avon Lake to Euclid)

The beaches in this area, with very few exceptions, are grossly polluted. Coliform counts in excess of 100,000 per 100 ml are quite frequent (Figure 3).

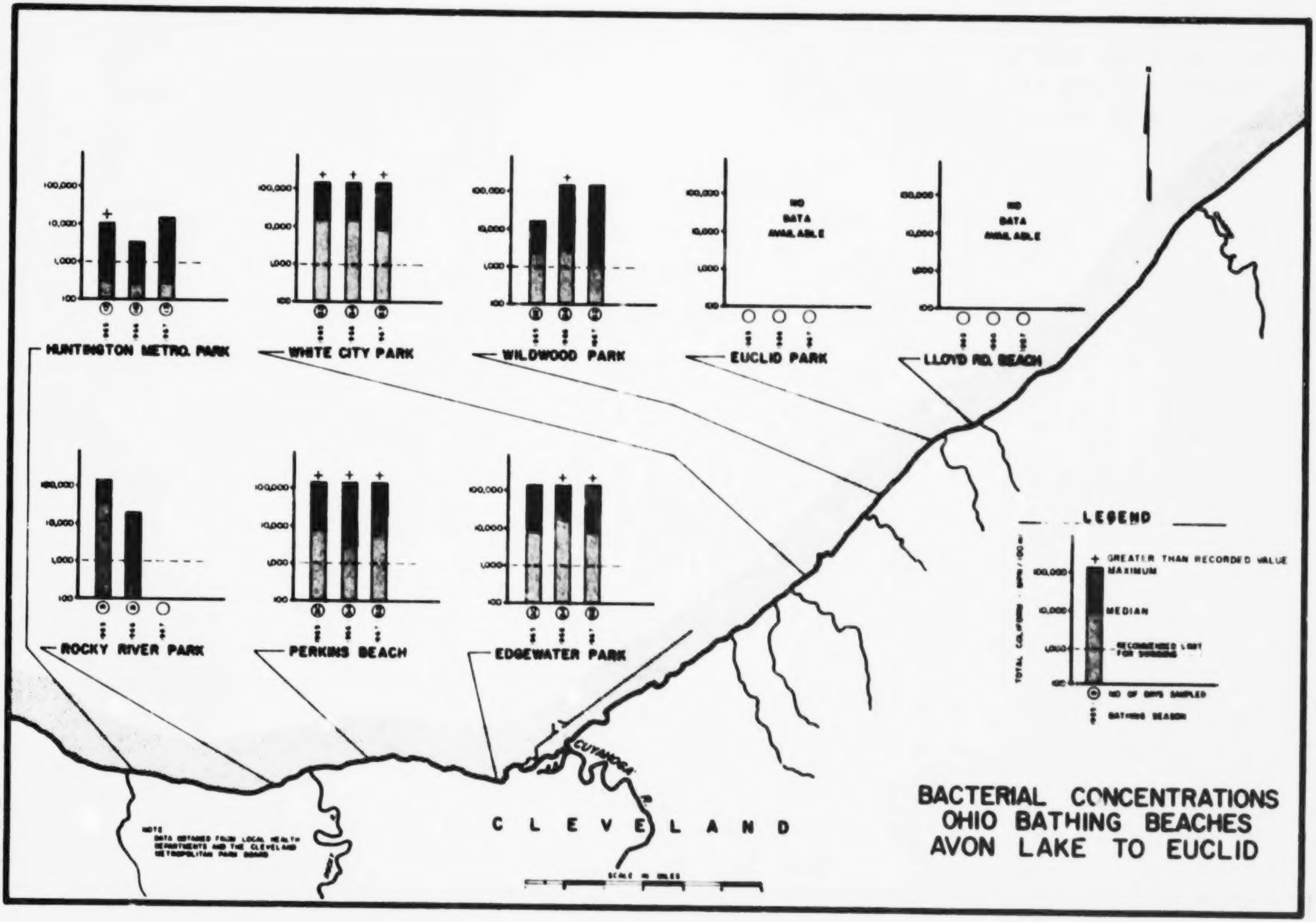
Many sources of pollution affect these beaches such as: (1) combined and storm sewer overflows, (2) municipal waste discharges from treatment plants at Rocky River, Lakewood, Cleveland (Westerly, Southerly and Easterly), Euclid and Willoughby-Eastlake, and (3) loadings from the heavily polluted tributaries within the area. In some areas, storm sewers continuously overflow due to the overloading from the rapidly developing suburbs. Raw sewage has been observed along the shoreline during periods of no rainfall.



BACTERIAL CONCENTRATIONS
OHIO BATHING BEACHES
TOLEDO TO AVON LAKE

TOLEDO AREA BEACHES
CRANE CREEK ST. PARK
PORT CLINTON CITY PARK
EAST HARBOR ST. PARK
SO BASS IS. ST. PARK
KELLEYS IS. ST. PARK
CEDAR POINT
HURON CITY PARK
VERMILION CITY PARK
LAKEVIEW PARK
CENTURY PARK
SHEFFIELD LAKE PARK
AVON LAKE PARK
NO DATA AVAILABLE
MEAN
1965
1966
1967
100
1,000
10,000
100,000
TOLEDO
SANDUSKY
LORAIN
PORTAGE
N
SCALE IN MILES
LEGEND
MAXIMUM
MEDIAN
RECOMMENDED LIMIT FOR SWIMMING
NO. OF DAYS SAMPLED
BATHING SEASON
TOTAL COLIFORMS/100ml
COMBINED RESULTS OF SAMPLES FROM SEVERAL LOCATIONS.
NOTE: DATA OBTAINED FROM OHIO HEALTH DEPT. & LOCAL HEALTH DEPARTMENTS

FIGURE 2



100,000
10,000
1,000
100
HUNTINGTON METRO. PARK
WHITE CITY PARK
WILDWOOD PARK
EUCLID PARK
LLOYD RD. BEACH
NO DATA AVAILABLE
NO DATA AVAILABLE
ROCKY RIVER PARK
PERKINS BEACH
EDGEWATER PARK
LEGEND
TOTAL COLIFORMS - MPN/100 ml
+ GREATER THAN RECORDED VALUE
MAXIMUM
MEDIAN
RECOMMENDED LIMIT FOR SWIMMING
NO OF DAYS SAMPLED
BATHING SEASON
CUYAHOGA
CLEVELAND
SCALE IN MILES
NOTE
DATA OBTAINED FROM LOCAL HEALTH DEPARTMENTS AND THE CLEVELAND METROPOLITAN PARK BOARD

BACTERIAL CONCENTRATIONS
OHIO BATHING BEACHES
AVON LAKE TO EUCLID

FIGURE 3

Euclid to Conneaut

Beaches in this area are generally of fair to good water quality with high bacterial counts (Figure 4) occurring during and immediately after rains and strong winds.

Generally, under normal meteorological conditions, the beaches in this area are out of the pollution-affected areas of Greater Cleveland. However, pollution problems are present at these beaches stemming principally from municipal waste discharges and bypasses from Ashtabula and Lake County sewage treatment plants, septic tank effluents, storm water discharges and the pollution-laden tributaries of northeastern Ohio.

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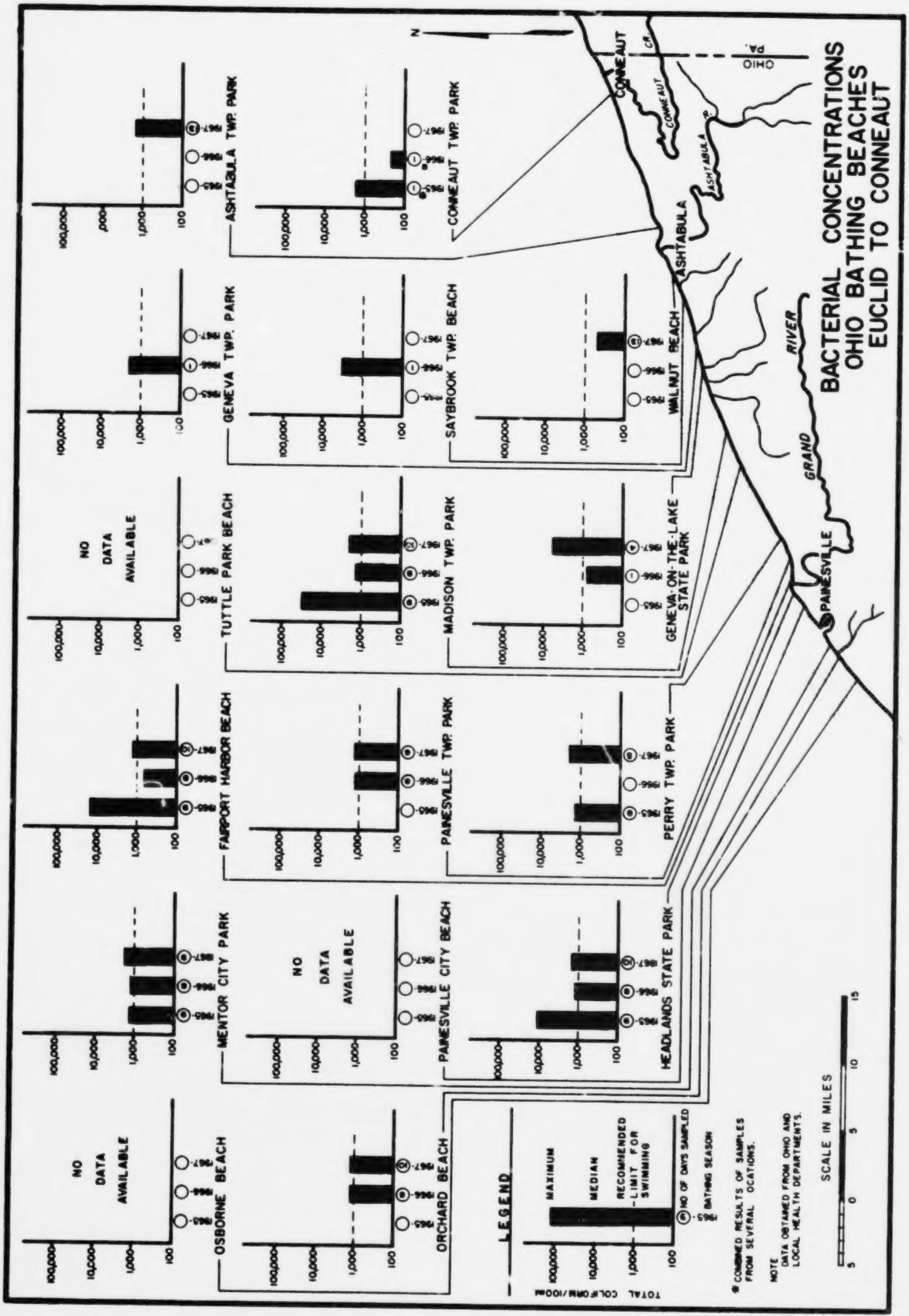
PENNSYLVANIA

By far the largest beach within the Lake Erie basin is Presque Isle State Park located at Erie. There are also small beaches in Pennsylvania which are used by individual communities. They are not considered bathing areas by the Pennsylvania Health Department since there is no lifeguard on duty at any time.

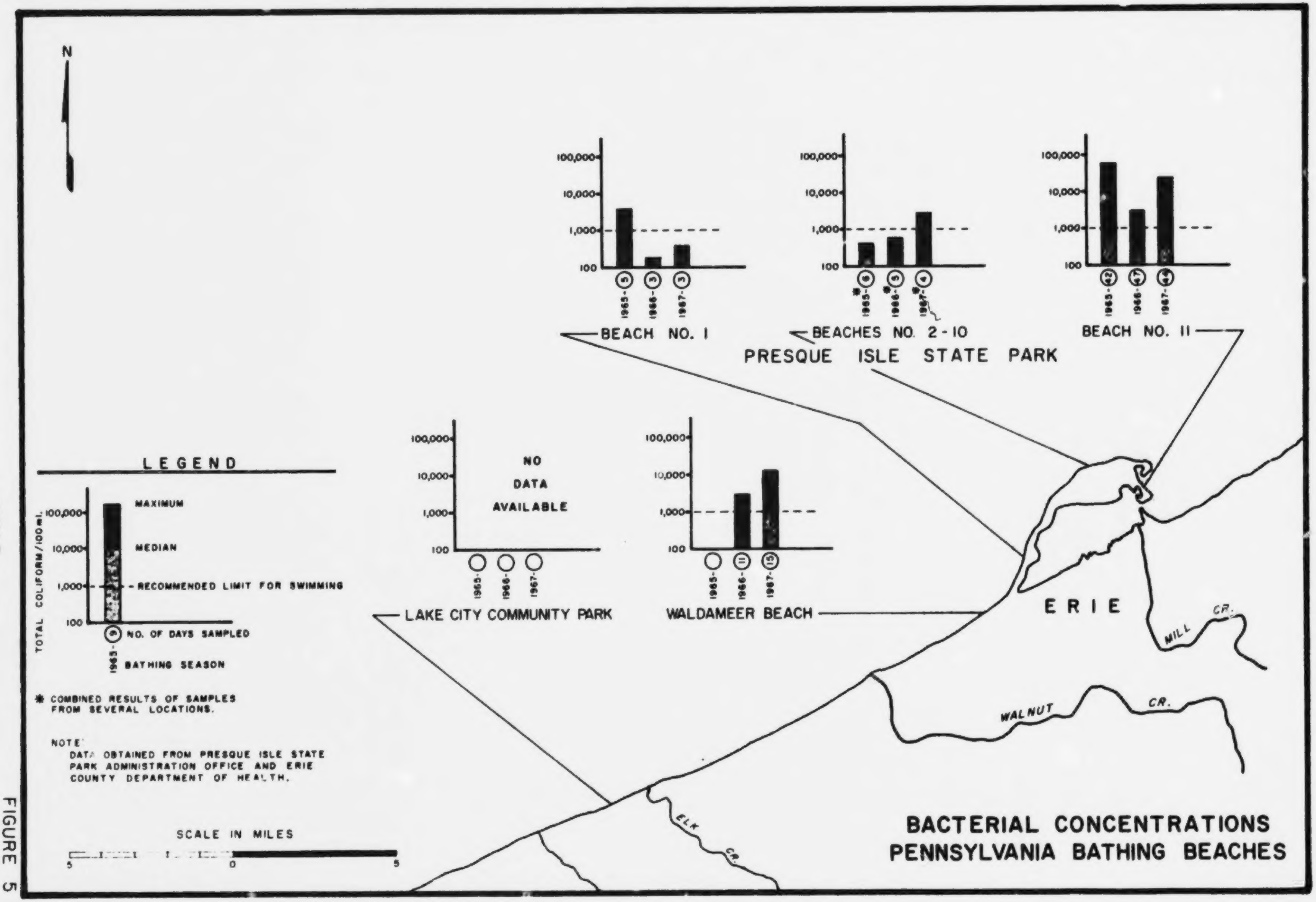
Figure 5 summarizes bacterial quality of Pennsylvania's beaches. Beaches 2-10 at Presque Isle are generally of excellent water quality and are heavily used. In past intensive testing, these beaches were never found to exceed the recommended bacterial standard, though esthetic problems from fish, algae, and paper wastes have occurred. Beach 1 is occasionally affected by septic tank effluents from the Kelso Beach and Beachcomber Hotel areas. The beaches at these two locations are likewise affected. High coliform concentrations have been recorded on Beach 11. These are caused by Mill Creek, the Erie sewage treatment plant bypasses, and storm sewer overflows. Beach 11 is closed by park officials when bacterial problems are found to exist. The effluent from the Hammermill Paper Co. reaches these beaches when winds are from the east. Hammermill's effluent contains tannins and lignins which discolor the water and produce foul odors and foam. A further source of pollution to Beach 11 is the bird sanctuary located immediately north of it.

All beaches east of Presque Isle are affected by algae. Also, under normal conditions the effluent from Hammermill adversely affects beaches for over ten miles east of Erie. Besides the color, odor, t[illegible], and foam problems associated with their wastes, wood chips are also found on beaches adjacent to their plant. Several of the small beaches east of Erie have excessive coliform concentrations, others are of unknown quality.


N
CONNEAUT
CONNEAUT CR.
OHIO
PA.
ASHTABULA
ASHTABULA R.
GRAND RIVER
PAINESVILLE
ASHTABULA TWP. PARK
CONNEAUT TWP. PARK
GENEVA TWP. PARK
SAYBROOK TWP. BEACH
WALNUT BEACH
TUTTLE PARK BEACH
MADISON TWP. PARK
GENEVA-ON-THE-LAKE STATE PARK
FAIRPORT HARBOR BEACH
PAINESVILLE TWP. PARK
PERRY TWP. PARK
MENTOR CITY PARK
PAINESVILLE CITY BEACH
HEADLANDS STATE PARK
OSBORNE BEACH
ORCHARD BEACH
NO DATA AVAILABLE
100,000
10,000
1,000
100
1965
1966
1967
LEGEND
TOTAL COLIFORM/100ml
MAXIMUM
MEDIAN
RECOMMENDED LIMIT FOR SWIMMING
NO OF DAYS SAMPLED
BATHING SEASON
* COMBINED RESULTS OF SAMPLES FROM SEVERAL LOCATIONS.
NOTE
DATA OBTAINED FROM OHIO AND LOCAL HEALTH DEPARTMENTS.
SCALE IN MILES
5
0
5
10
15

BACTERIAL CONCENTRATIONS
OHIO BATHING BEACHES
EUCLID TO CONNEAUT

FIGURE 4



BACTERIAL CONCENTRATIONS
PENNSYLVANIA BATHING BEACHES

N
BEACH NO. 1
BEACHES NO. 2 - 10
BEACH NO. 11
PRESQUE ISLE STATE PARK
LAKE CITY COMMUNITY PARK
WALDAMEER BEACH
NO DATA AVAILABLE
100,000
10,000
1,000
100
1965-5
1966-3
1967-3
1965-6
1966-5
1967-4
1965-42
1966-47
1967-44
1965-
1966-
1967-
1965-
1966-11
1967-15
ERIE
MILL CR.
WALNUT CR.
ELK CR.
LEGEND
TOTAL COLIFORM/100ml.
MAXIMUM
MEDIAN
RECOMMENDED LIMIT FOR SWIMMING
NO. OF DAYS SAMPLED
1965-9
BATHING SEASON
SCALE IN MILES
5
0
5

* COMBINED RESULTS OF SAMPLES FROM SEVERAL LOCATIONS.

NOTE:
DATA OBTAINED FROM PRESQUE ISLE STATE PARK ADMINISTRATION OFFICE AND ERIE COUNTY DEPARTMENT OF HEALTH.

FIGURE 5

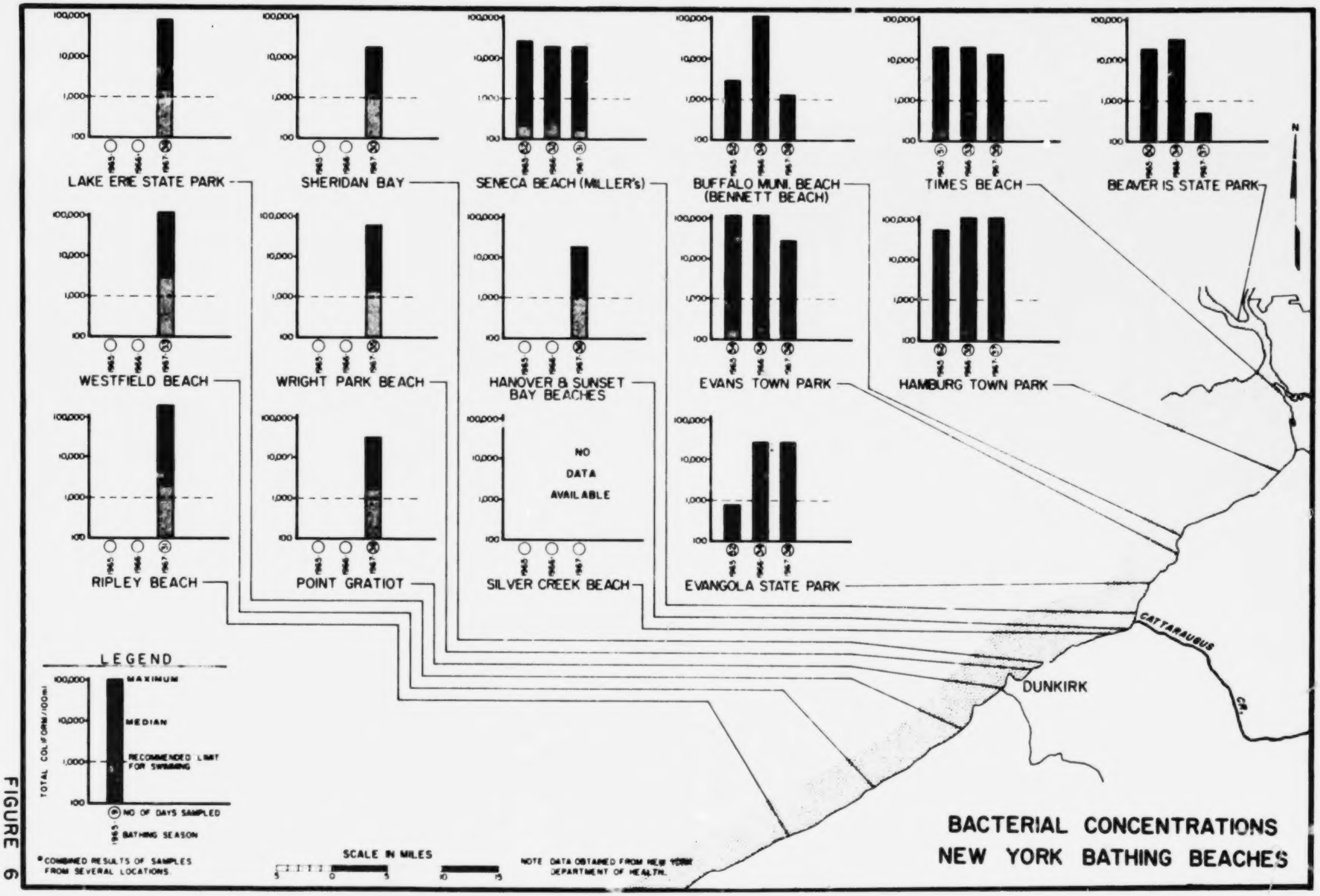
NEW YORK

Figure 6 summarizes the bacterial data collected by Erie and Chautauqua County Health Departments. Median coliform concentrations are fairly high for beaches in Chautauqua County while the median concentrations are lower for beaches in Erie County.

Pollution sources to these beaches are primarily storm and combined sewer overflows, pollution laden streams in the area, municipal waste treatment plant effluents and bypasses, and septic tank effluents.

The maximum coliform concentrations were found to be associated with meteorological conditions. Beach surveys conducted by Erie County Health Department indicate that winds are a major factor in pollution of the beaches. Pollution from Cattaraugus Creek is kept near shore with high winds and affects the water quality of several Erie County beaches. Enteric pathogens have been isolated from the Buffalo River.

All New York area beaches are affected by heavy algal growths which are washed into long windrows along beach areas, particularly in coves and other shoreline indentations. These algae, produced by nutrients discharged to the lake from sources within New York and neighboring Lake Erie states, cause extensive esthetic problems as they decompose. As an example, at Lake Erie State Park, bathers must go to the end of a concrete pier before attempting to enter the water to avoid the foul slimes of decomposing algae.



BACTERIAL CONCENTRATIONS
NEW YORK BATHING BEACHES

FIGURE 6

CONCLUSIONS

1. All Lake Erie beaches are adversely affected at least occasionally by bacterial pollution, esthetic impairment, or both.

2. Bacterial pollution varies from major continuous problems at some beaches to occasional or infrequent problems at others. The following table summarizes the bacterial quality at sixty Lake Erie beaches.

3. Pollution sources to Lake Erie beaches include sewer overflows, municipal treatment plant bypasses, inadequately disinfected effluents, septic tank discharges, urban and rural runoff, and industrial waste discharges.

4. The principal esthetic problem is that of algae fouling beach areas. Without adequate beach maintenance programs, obnoxious and unsightly conditions are created by the decomposition of these algae. Other esthetic impairments are caused by discoloration, oil, garbage, trash, and other debris.

5. The primary purpose of a bathing beach surveillance program is not only the determination of water quality but the location of all pollution sources to the beach and its effect on the water quality. The objective of the program is not to close down presently polluted beaches but to remove the pollutants at their source so as to eliminate or at least reduce the need for future closures.

6. Although a necessary step for the protection of public health is the posting of polluted beaches, this action should be only temporary. An unsafe beach should immediately establish an active program to abate pollution and the needed additions and corrections to existing facilities should be a high priority in any pollution control program.

WATER QUALITY OF LAKE ERIE BATHING BEACHES

Unsafe	Questionable Moderate Pollution	Generally Safe Slight Pollution	Safe
MICHIGAN			
	Sterling State	Pointe Aux Peaux	
		Stony Point	
		Willow	
		Toledo	
OHIO			
Toledo Area	Century	Crane Creek State	Cedar Point
Rocky River	Sheffield Lake	East Harbor State	
Perkins	Avon Lake	Lakeview	
Edgewater		Huntington Metro.	
White City		Osborne	
Wildwood		Orchard	
Euclid		Mentor City	
Lloyd Road		Painesville City	
		Headlands State	
		Fairport Harbor	
		Painesville Township	
		Perry Township	
		Tuttle	
		Madison Township	
		Geneva-on-the-Lake State	
		Geneva Township	
		Walnut	
PENNSYLVANIA			
	Presque Isle State (Beach #11)	Presque Isle State (Beach #1)	Presque Isle State (Beaches #2-10)
	Waldameer		
NEW YORK			
Westfield	Ripley	Seneda (Millers)	Beaver Island State
Silver Creek	Lake Erie State	Evans Town	
Hamburg Town	Point Gratiot	Evangola State	
	Wright	Buffalo Municipal	
	Sheridan Bay	Times	
	Hanover Beach & Sunset Bay		

Insufficient data available to evaluate water quality at the following beaches: South Bass Island State, Port Clinton City, Kelleys Island State, Huron City, Vermilion City, Saybrook Township, Ashtabula Township, Conneaut Township in Ohio and Lake City Community in Pennsylvania.

LAKE ERIE BATHING BEACH SURVEY

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
			MICHIGAN		
Monroe County					
Pointe Aux Peaux (Private beach open to public)	Open	Algae & silt - Peat from Lake Erie washes ashore with easterly winds.	Michigan Water Res. Comm. & Monroe Co. Health Dept.	Community to be sewered by 1970. Bacteriological tests show safe waters for bathing.	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem.
Stony Point Park (Private beach open to public)	Open	Algae & silt - Peat from Lake Erie washes ashore with easterly winds.	Michigan Water Res. Comm. & Monroe Co. Health Dept.	In 1966 this beach was declared unsafe by the Monroe Co. Health Dept. No storm or septic tank discharges within immediate area. Sewers to be in by 1969.	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem.
Willow Beach (Private beach open to the public)	Open	Algae & silt - Peat from Lake Erie washes ashore with easterly winds.	Michigan Water Res. Comm. & Monroe Co. Health Dept.	Stony Creek discharge and storm water pump stations. All beach areas should be sewered by 1970.	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem. Bottom contains considerable amount of muck.
Sterling State Park	Posted- Unsafe for Swimming	Bacteria, algae, trees silt, debris, oil, sewage	Michigan Water Res. Comm.	Sewage collection and treatment needed. Rest room facilities discharge wastes to Monroe Co. STP by pressure lines. The park will tie into a gravity flow sewer when it becomes available. Sandy Creek (with sewage) discharges to Sterling State Park Beach. Plans to correct this situation are being evaluated.	Questionable, moderate pollution. Algal problem.
Toledo Beach (Private beach open to the public)	Open	Algae - silt - Peat from Lake Erie washes ashore with easterly winds.	Michigan Water Res. Comm. & Monroe Co. Health Dept.	Beach area to be sewered by 1969.	Generally safe, slight pollution. High coliform concentrations in 1967. Algal problem.

LAKE ERIE BATHING BEACH SURVEY (Continued)

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
			OHIO		
Lucas County					
Toledo Area Beaches	No information available.	Bacteria	Lucas Co. Health Department	No longer collects samples. County recommends against swimming because of polluted conditions.	Estimated unsafe. Algal problem.
Crane Creek State Park	Open	No data available on physical conditions of beach.	Ohio Dept. of Nat. Resources, Div. of Parks & Recreation	Beach closed 1-2 days after heavy rains.	Generally safe, slight pollution. Occasional high bacterial counts. Occasional algal problem. Reports of jelly globular substance after strong north winds believed to be of oil or grease origin.
Ottawa County					
Port Clinton City Park	Open	No information available	No information available	None	Insufficient data to evaluate water quality situation
East Harbor State Park	Open	No data available on physical conditions of beach.	Ohio Dept. of Nat. Resources, Div. of Parks & Recreation	None	Generally safe, slight pollution. Occasional high coliform concentrations.
So. Bass Island State Park	Open	No information available	Ohio Dept. of Nat. Resources, Div. of Parks & Recreation	None	Insufficient data to evaluate water quality situation. Algal problem.
Erie County					
Kelleys Island State Park	Open	No information available	Ohio Dept. of Nat. Resources, Div. of Parks & Recreation	None	Insufficient data to evaluate water quality situation. Algal problem.

LAKE ERIE BATHING BEACH SURVEY (Continued)

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
Erie County (Cont'd)					
Cedar Point (Private beach open to the public)	Open	Some debris & algae - silt and oil	City of Sandusky & Ohio Dept. of Health	None	Estimated safe. Limited data indicates acceptable bacterial conditions. Occasional algal problem. Reported to have grease balls washed onto beach.
Huron City Park	Open	No information available	None	Storm drain outfall in beach area.	Insufficient data to evaluate water quality situation.
Lorain County					
Vermilion City Park	Open	Algae, debris	None	None	Insufficient data available to evaluate water quality situation.
Lakeview Park	Open	Algae, logs, debris, dead fish	City of Lorain	Outfalls at center of beach and each end.	Estimated generally safe, slight pollution. Insufficient data to evaluate water quality situation. Lorain City Health Department recommends beaches be closed.
Century Park	Open	Algae, logs, debris, dead fish.	City of Lorain	Outfall at east end of beach.	Estimated as questionable. Insufficient data to evaluate water quality situation. Lorain City Health Dept. recommends beaches be closed.
Sheffield Lake Park	Open	No information available	None in recent years	Repeated tests showed continuing contamination and testing was discontinued.	Estimated as questionable, moderate pollution. Insufficient data to evaluate water quality situation. Lorain Co. Health Dept. recommends against swimming.

LAKE ERIE BATHING BEACH SURVEY (Continued)

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
Lorain County (Cont'd)					
Avon Lake Park	Open	No information available	None in recent years	Repeated tests showed continuing contamination and testing was discontinued.	Estimated as questionable, moderate pollution. Insufficient data to evaluate water quality situation. Lorain Co. Health Dept. recommends against swimming.
Cuyahoga County					
Huntington Metropolitan Park	Open	Algae and dead fish	Cleveland Metropolitan Park Board	No sanitary outfall - small stream with storm flow at east end of beach. Water quality in 1967 best for several years.	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem.
Rocky River Park	Posted	High coliform concentrations	City of Rocky River & Cuyahoga County Health Department	None	Estimated unsafe. Excessively high coliform concentrations
Perkins Beach	Posted but open	Bacteria, debris	City of Cleveland	None	Unsafe - Excessively high coliform concentrations.
Edgewater Park	Posted but open	Bacteria, debris	City of Cleveland	None	Unsafe - Excessively high coliform concentrations.
White City Park	Posted but open	Bacteria, debris	City of Cleveland	None	Unsafe - Excessively high coliform concentrations.
Wildwood Park	Posted but open	Bacteria, debris	City of Cleveland	None	Unsafe - Excessively high coliform concentrations.

LAKE ERIE BATHING BEACH SURVEY (Continued)

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
Cuyahoga County (Cont'd)					
Euclid Park	Posted	Bacteria	None in recent years	Presently posted against swimming by City of Euclid due to pollution.	Unsafe - excessively high coliform concentrations.
Lloyd Road Beach	Posted	Bacteria	None in recent years	Presently posted against swimming by City of Euclid due to pollution.	Unsafe - excessively high coliform concentrations.
Lake County					
Osborne Beach (Willoughby Beach)	Open	No information available	Lake Co. Health Dept.	None	**Estimated as generally safe, slight pollution.**
Mentor City Park	Open	Algae, septic tank effluent	Lake Co. Health Dept.	Storm sewer carrying septic tank wastes flow daily. By next summer all septic tanks should be abandoned.	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem.
Orchard Beach	Open	No information available	Lake Co. Health Dept.	Storm sewer discharge near beach contains some septic tank wastes. New sanitary sewers installed this summer should eliminate septic tank waste discharge.	Generally safe, slight pollution. Occasional high coliform concentrations.
Painesville City Beach	Open	No information available	City of Painesville	None	Estimated as generally safe, slight pollution.
Headlands State Park	Open	No information available	Lake Co. Health Dept.	Flush toilets and new sewage treatment plant under construction. Beach near mouth of Grand River but protected by half mile breakwall. Northeast wind might cause increase in coliform.	Generally safe, slight pollution. Occasional high coliform concentrations.
Fairport Harbor Beach	Open	Trees	Lake Co. Health Dept.	Southeast of Grand River. River receives industrial wastes, treated sanitary wastes from Painesville and Fairport and untreated wastes from Grand River Village.	Generally safe, slight pollution. Occasional high coliform concentrations.

LAKE ERIE BATHING BEACH SURVEY (Continued)

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
Lake County (Cont'd)					
Painesville Township Park	Open	No information available	City of Painesville	None	Estimated as generally safe, slight pollution.
Perry Township Park	Open	No information available	Lake Co. Health Dept.	None	Generally safe, slight pollution. Occasional high coliform counts.
Tuttle Park Beach	Open	No information available	None in 1967	None	Estimated as generally safe, slight pollution.
Madison Township Park	Open	Algae	Lake Co. Health Dept.	Storm Creek outlet about one thousand feet east of beach.	Generally safe, slight pollution. Occasional high coliform concentrations.
Ashtabula County					
Geneva-on-the-Lake State Park	Open	Algae, debris	Village of Geneva-on-the-Lake & Ashtabula Co. Health Dept.	Pollution sources are diluted somewhat by the time they reach beach.	Estimated as generally safe, slight pollution. Algal problem.
Geneva Township Park	Open	Algae, debris, logs	Ashtabula Co. Health Dept.	None	Estimated as generally safe, slight pollution.
Saybrook Township Beach	Open	Algae, logs, debris, sewage	Ashtabula Co. Health Dept.	Main source of pollution from large trailer park and cottage area directly to the west.	Insufficient data to evaluate water quality situation.
Walnut Beach	Open	No information available	City of Ashtabula	None	Estimated as generally safe, slight pollution. Indication of occasional high coliform concentrations.
Ashtabula Township Park (Lakeshore Park)	Open	Algae, logs, debris	City of Ashtabula	None	Insufficient data to evaluate water quality situation.
Conneaut Township Park	Open	None	City of Conneaut	None	Insufficient data to evaluate water quality situation.

LAKE ERIE BATHING BEACH SURVEY (Continued)

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
			PENNSYLVANIA		
Erie County					
Lake City Community Park	Open	Algae	None	No nuisance conditions	Insufficient data to evaluate water quality situation.
Waldameer Park (Beachcomber Hotel) (Private beach open to public)	Open	Algae	Pa. Health Dept. & Erie Co. Health Dept.	Open sewage lagoon discharge on property into bathing area. Water quality nuisance conditions are relatively unchanged in recent years.	Questionable, moderate pollution. Data indicate high coliform counts quite frequently.
Presque Isle State Park					
Beach #1	Open	Algae (periodic in fall) Fish kill early summer. High coliform.	Pa. State Park & Harbor Comm., & Erie Co. Health Dept.	Periodic high coliform counts result from establishments located west of park. Remedial action ordered. No outfall occurs from park facilities. Greatest problems other than coliform are dead fish and algae from Lake Erie.	Estimated from intensive study in 1964 as generally safe, slight pollution. Recent sampling data is insufficient to make evaluation but indications are that similar conditions exist.
Beaches #2-10	Open	Dead fish and algae	Pa. State Park & Harbor Comm., & Erie Co. Health Dept.	These beaches test out good. No outfalls occur in this area. Dead fish and algae from lake occasionally wash onto beaches.	Estimated as safe. Intensive study in 1964 revealed excellent water quality. Recent sampling date is insufficient to make evaluation.
Beach #11	Beach closed one day in 1967	Coliform, algae, dead fish	Pa. State Park & Harbor Comm., & Erie Co. Health Dept.	High counts are due to outfall of Erie Sewage Disposal about one mile away. Improper chlorination in the past, questionable operations and inadequate treatment of sewage are factors. No outfall exists from park facilities. Water quality in 1967 was better than previous.	Questionable, moderate pollution. Intensive study in 1964 revealed high coliform concentrations quite frequently. Recent sampling data indicate similar situation.

LAKE ERIE BATHING BEACH SURVEY (Continued)

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
			NEW YORK		
Chautauqua County					
Ripley Beach	Open	Odors from decaying aquatic plants in late summer	Chautauqua Co. Health Dept.	Not an officially supervised beach and was not officially open, but the public used it extensively last year.	Questionable, moderate pollution. Data for 1967 indicate high median coliform concentrations. Algal problem.
Westfield Beach	Closed in 1967	No information available	Chautauqua Co. Health Dept.	None	Unsafe. Data for 1967 indicate high median coliform concentrations. Algal problem.
Lake Erie State Park	Open	Bacteria. Odors from decaying aquatic plants in late summer	Chautauqua Co. Health Dept.	High coliform concentrations. Sanitary survey failed to indicate sources of pollution.	Questionable, moderate pollution. Data for 1967 indicate high median coliform concentrations. Excessive algal problem.
Point Gratiot Beach	Open	Bacteria. During August decaying aquatic plants create nuisance conditions.	Chautauqua Co. Health Dept.	High coliform concentrations. Sanitary survey failed to indicate sources of pollution.	Questionable, moderate pollution. Data for 1967 indicate high median coliform concentrations. Algal problem. Intensive study in 1964 indicated beach affected by septic tanks and Canadaway Cr.
Wright Park Beach	Open	Odors from decaying aquatic plants in late summer	Chautauqua Co. Health Dept.	None	Questionable, moderate pollution. Data for 1967 indicate high median coliform concentrations. Algal problem. Intensive study in 1964 indicated beach affected by stream and sewage plant.
Sheridan Bay	Open	Odors from decaying aquatic plants in late summer	Chautauqua Co. Health Dept.	None	Questionable, moderate pollution. Data for 1967 indicate high median coliform concentrations. Algal problem.

LAKE ERIE BATHING BEACH SURVEY (Concluded)

Beach	Status	Problems	Monitoring Agency	Remarks	Evaluation by FWPCA
Chautauqua County (Cont'd)					
Silver Creek Beach	Closed in 1967	No information available	Chautauqua Co. Health Dept.	None	Estimated as unsafe.
Hanover & Sunset Bay Beaches	Open	Odors from decaying aquatic plants in late summer	Chautauqua Co. Health Dept.	None	Questionable, moderate pollution. Data for 1967 indicate excessively high coliform concentrations. Algal problem.
Erie County					
Seneca Beach (Millers Beach) (Private beach open to public)	Open	No information available on physical conditions	Erie Co. Health Dept.	None	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem.
Evangola State Park	Open	No information available on physical conditions	Erie Co. Health Dept.	None	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem.
Evans Town Park	Open	No information available on physical conditions	Erie Co. Health Dept.	None	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem.
Buffalo Municipal Beach (Bennett Beach)	Open	No information available on physical conditions	Erie Co. Health Dept.	None	Generally safe, slight pollution. Occasional high coliform concentrations. Algal problem.
Hamburg Town Park	Closed in 1966 & 1967	bacteria - algae	Erie Co. Health Dept.	High coliform concentrations. High turbidity after storms. Location and topography makes beach local collection basin for surrounding pollution.	Unsafe. Excessively high coliform concentrations. Algal problem.
Times Beach	No information available	No information available	Erie Co. Health Dept.	None	Estimated generally safe, slight pollution. No 1967 bacterial data. Subject to periodic flushing of Buffalo River.
Beaver Island	Open	Occasional algae	Erie Co. Health Dept.	Only extremely unfavorable weather causes treatment plant and storm sewer effluent to adversely affect bathing quality.	Safe. Generally maintains excellent water quality as long as City of Buffalo chlorinates treatment plant effluent. Also can be affected by Buffalo storm overflow.

LAKE ERIE ENVIRONMENTAL SUMMARY

1963-1964

UNITED STATES
DEPARTMENT OF INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
GREAT LAKES REGION

MAY 1968

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CHAPTER 1

INTRODUCTION

The Federal Water Pollution Control Administration and its antecedent, the Division of Water Supply and Pollution Control of the U. S. Public Health Service, have gathered a great amount of data on the physical, chemical, and biological characteristics of Lake Erie. Various reports by those agencies and others have been based on the gathered data.

This report is an attempt to summarize the information gathered in the years 1963 through 1965. The purposes are (1) to provide a document for validating previous reports on the pollution problems in Lake Erie and (2) to provide a base for comparison with future lake surveillance data.

Adequate understanding of the significance of the reported data requires a knowledge of physical features and history of the basin, as summarized in the following description.

AREA DESCRIPTION

GENERAL

Lake Erie is centered at 42°15' North Latitude and 81°15' West Longitude, with its long axis oriented at about N70°E. The lake is approximately 240 miles long and more than 50 miles wide near the midpoint of its long axis. Figure 1 shows the Lake Erie basin as described in this report.

The area of the Lake Erie basin is about 32,500 square miles--about 40,000 square miles if the Lake St. Clair drainage area is included. Nearly one-third (9,940 square miles) of the Lake Erie basin is covered by the lake itself, a ratio which is approximated in each of the other Great Lakes basins. However, Lake Erie receives the drainage of the three lake basins above it, so that the total watershed supplying Lake Erie is in reality 260,000 square miles.

In terms of surface area, Lake Erie ranks fourth of the five Great Lakes. Only twelve freshwater lakes in the world are larger. The depth of Lake Erie, however, is remarkably shallow, averaging only 60 feet and reaching a maximum of 216 feet. Its total volume is 125 trillion gallons, the smallest of the Great Lakes (see Figure 2 and Table 1), storing only two percent of the total Great Lakes volume.

TABLE I

PHYSICAL FEATURES OF GREAT LAKES SYSTEM

Lake	Length (miles)	Breadth (miles)	Water Area (sq. miles) U.S.	Canada	Total	Mean Depth (feet)	Drainage area (sq. miles)
Superior	350	160	20,700	11,200	31,900	487	80,000
Michigan	307	118	22,400	--	22,400	276	67,860
Huron	206	183	9,110	13,900	23,010	195	72,620
St. Clair	26	24	200	290	490	10	7,430
Erie	241	57	4,990	4,940	9,930	60	32,490
Ontario	193	53	3,600	3,920	7,520	283	34,800
Totals			61,000	34,250	95,250		

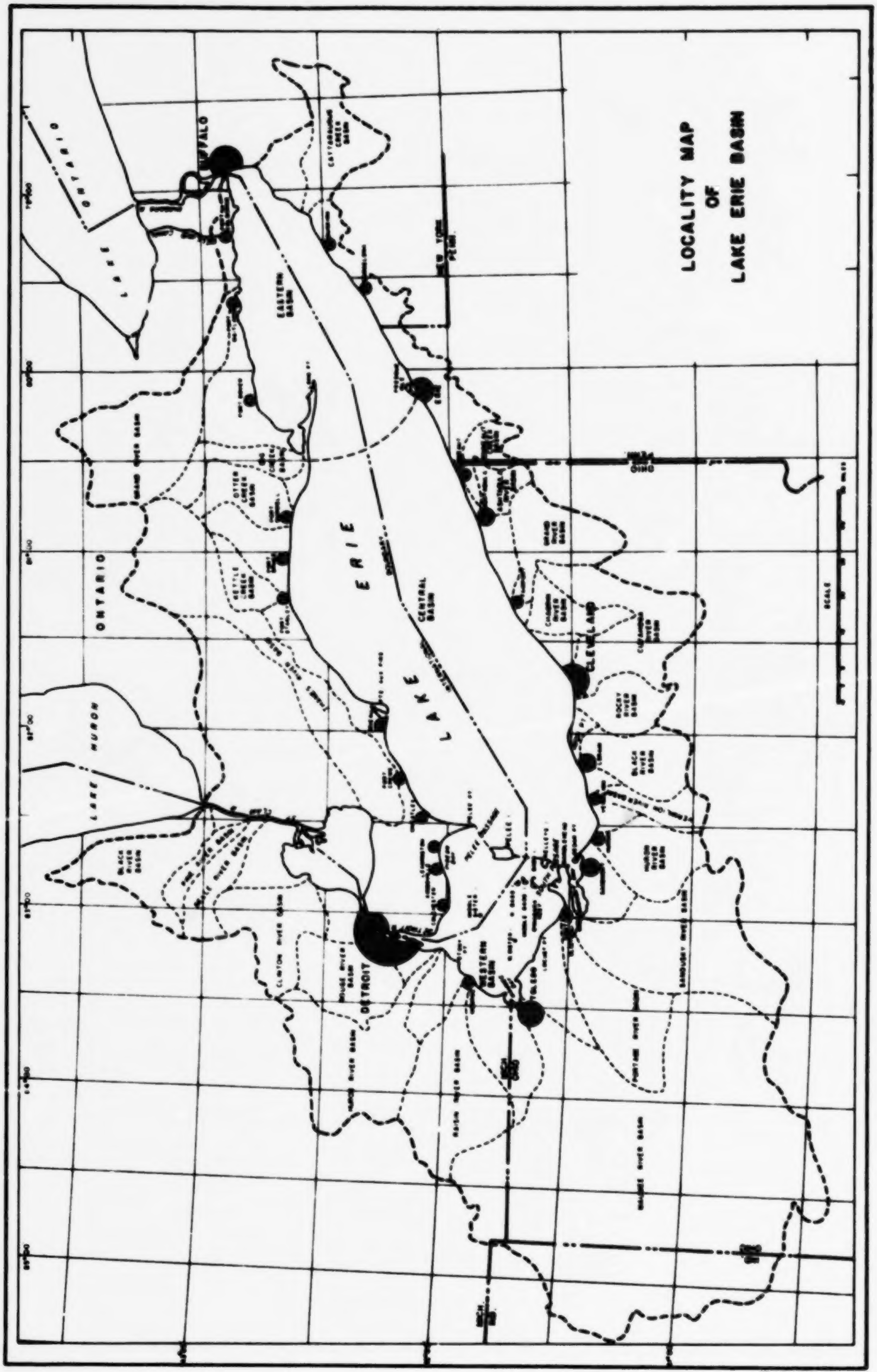
LOCALITY MAP OF LAKE ERIE BASIN
LAKE ERIE
LAKE ONTARIO
LAKE HURON
ONTARIO
BUFFALO
CLEVELAND
DETROIT
TOLEDO
EASTERN BASIN
CENTRAL BASIN
WESTERN BASIN
CATTARAUGUS CREEK BASIN
GRAND RIVER BASIN
CHAGRIN RIVER BASIN
CUYAHOGA RIVER BASIN
ROCKY RIVER BASIN
BLACK RIVER BASIN
HURON RIVER BASIN
SANDUSKY RIVER BASIN
PORTAGE RIVER BASIN
MAUMEE RIVER BASIN
RAISIN RIVER BASIN
ROUGE RIVER BASIN
CLINTON RIVER BASIN
NEW YORK
PENN.
OHIO
SCALE

FIGURE 1

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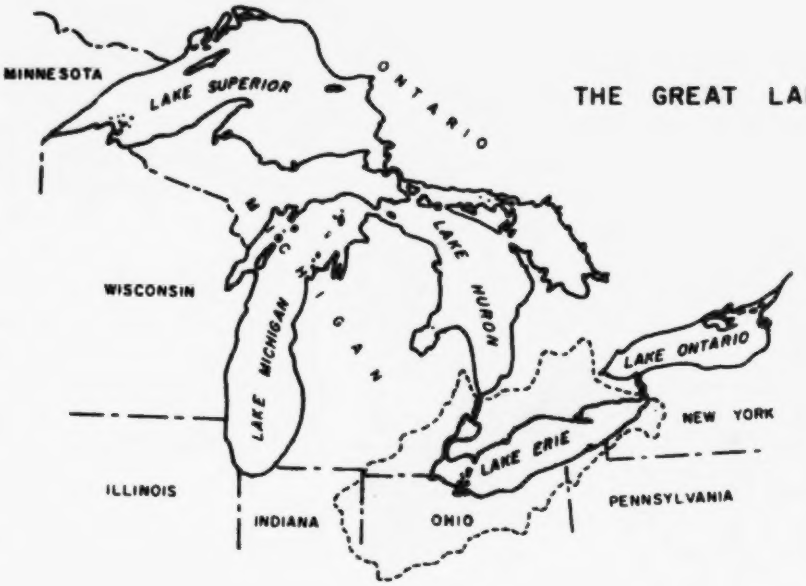
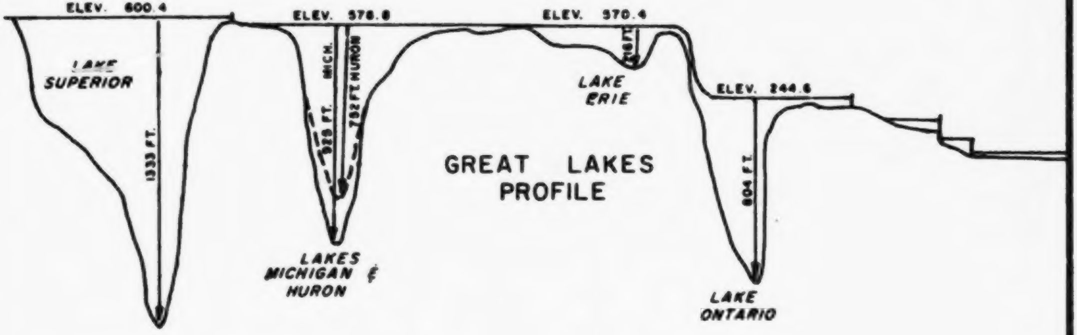
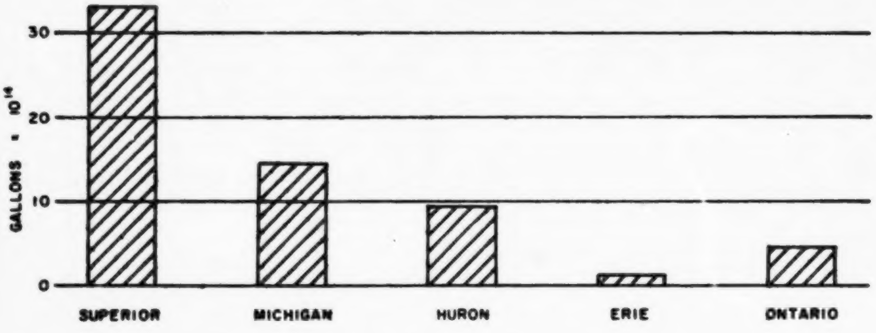
THE GREAT LAKES


MINNESOTA
LAKE SUPERIOR
ONTARIO
MICHIGAN
LAKE HURON
WISCONSIN
LAKE MICHIGAN
LAKE ONTARIO
NEW YORK
LAKE ERIE
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA

GREAT LAKES PROFILE


ELEV. 600.4
LAKE SUPERIOR
1333 FT.
ELEV. 576.8
MICH.
923 FT.
752 FT HURON
LAKES MICHIGAN & HURON
ELEV. 570.4
LAKE ERIE
ELEV. 244.6
804 FT.
LAKE ONTARIO



GREAT LAKES STORAGE

FIGURE 2

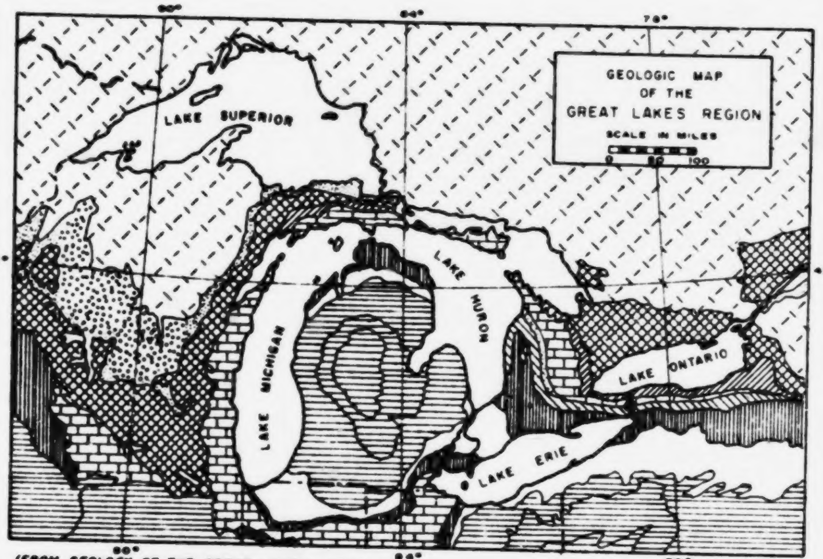
The water of Lake Erie lies entirely above that of Lake Ontario, into which it drains. Lake Erie owes its existence both to the Niagara bedrock sill, which acts as a dam, and to glacial scouring during the Ice Age. The form of Lake Erie reflects the bedrock structure of the area, Figure 3.

The landscape of the Lake Erie basin is characterized by thousands of square miles of flat terrain, broken only by occasional ancient beach ridges and relatively steep valley walls in many of the major tributaries. Even these features are subdued in the western part of the basin. The terrain is less monotonous from Cleveland eastward, along the south shore, where the basin reaches into the northwestern perimeter of the Appalachian uplands with their rolling hills. However, the basin there is relatively narrow between the lake and the drainage divide.

Soils in the extensive flatlands of the Lake Erie basin are characteristically dominated by poorly drained and relatively impervious clays, derived from old lake and glacial sediments, Figure 4. These soils are fertile and, because of this, have been artificially drained to a great extent. The uplands along the southeast edge of the basin are well-drained, rock-derived, and less fertile. Old beach ridges throughout the basin are extensively used for highways and farming.

Streams entering Lake Erie are generally low-gradient and winding but with steep-walled valleys. They carry large silt loads where they traverse easily eroded clay flatlands and smaller loads in the rocky hilly areas. Excluding the Detroit River input, only two streams, the Maumee River in Ohio and the Grand River in Ontario, supply significant quantities of water to the lake.

Lake Erie proper is unique among the Great Lakes in several of its natural characteristics, each of which has a direct bearing on its condition with respect to pollution. Lake Erie is by far the shallowest of the Great Lakes and the only one with its entire water mass above sea level. It has the smallest volume, 113 cubic miles, and its flow-through time of 920 days is the shortest. It is the most biologically productive and the most turbid. It has the flattest bottom; it is subject to the widest short-term fluctuations in water level (13 feet maximum); and its seasonal average surface levels are the most unpredictable. It is the only one of the Great Lakes with its long axis paralleling the prevailing wind direction and is subject to violent storms. Lake Erie is also the southernmost, warmest, (averaging 51°F) and the oldest (12,000 years) of the Great Lakes.


GEOLOGIC MAP
OF THE
GREAT LAKES REGION
SCALE IN MILES
0 50 100
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ONTARIO
LAKE ERIE
90°
84°
78°
45°

(FROM GEOLOGY OF THE GREAT LAKES, HOUGH, 1958)

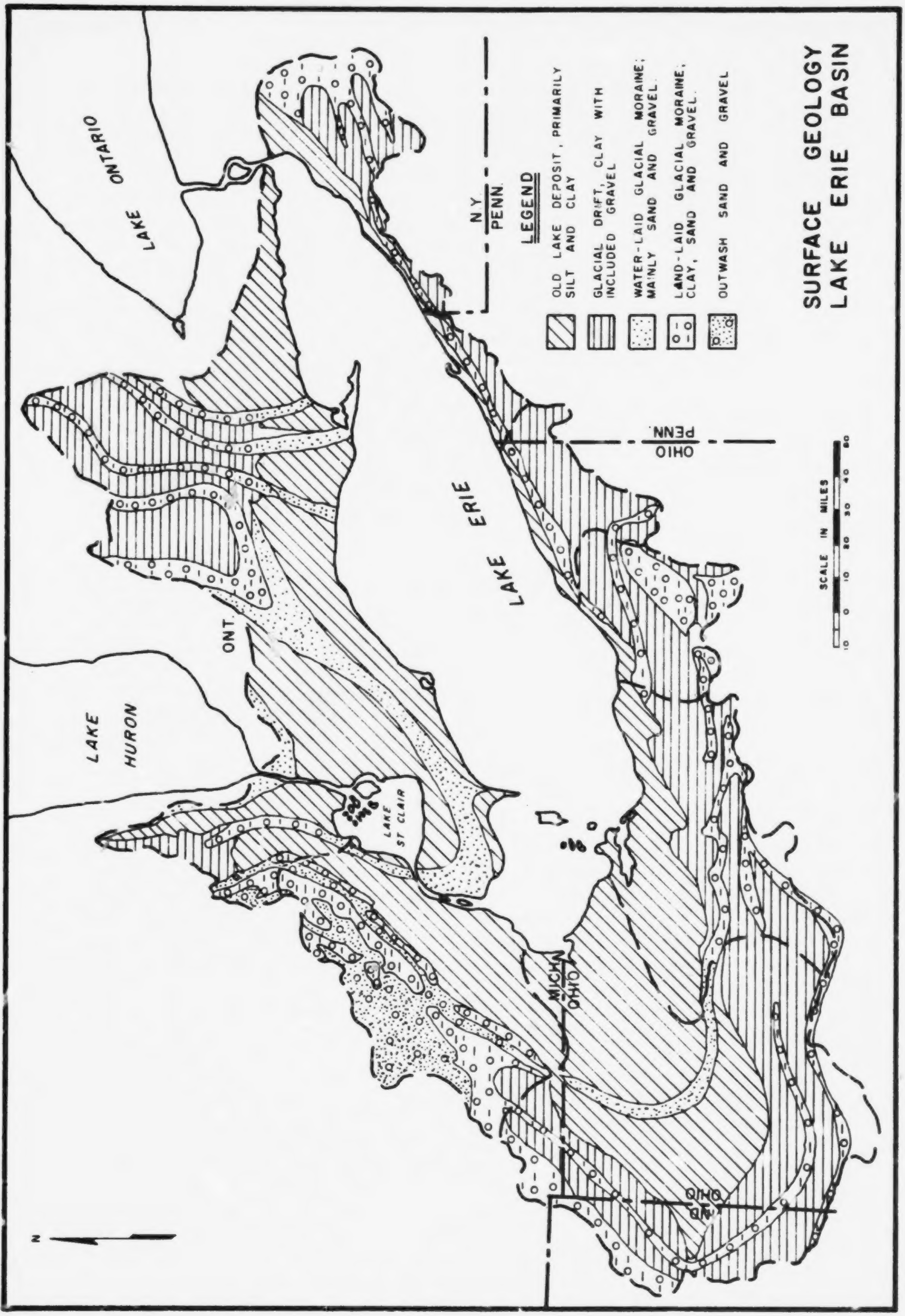
LEGEND

- ▤ PENNSYLVANIAN AND MISSISSIPPIAN ROCKS, UNDIFFERENTIATED
- □ UPPER DEVONIAN ROCKS, MAINLY SHALES. ANTRIM SHALE IN MICHIGAN
- ■ LOWER DEVONIAN ROCKS, IN UNITED STATES. DEVONIAN UNDIFFERENTIATED IN CANADA
- ▧ UPPER SILURIAN ROCKS, IN ONTARIO AND NEW YORK (MAINLY DOLOMITE)
- ░ SILURIAN SALINA GROUP ROCKS IN NORTHERN MICHIGAN AND ONTARIO (INCLUDES SALT BEDS)
- ⊞ MIDDLE SILURIAN NIAGARAN SERIES ROCKS IN NORTHERN MICHIGAN, ONTARIO, AND NEW YORK. SILURIAN ROCKS UNDIFFERENTIATED IN WISCONSIN, IOWA, ILLINOIS, INDIANA, AND OHIO
- ▨ LOWER SILURIAN ROCKS IN NORTHERN MICHIGAN, ONTARIO, AND NEW YORK
- ▩ ORDOVICIAN ROCKS, UNDIFFERENTIATED.
- ░ CAMBRIAN ROCKS, UNDIFFERENTIATED
- ⊠ PRECAMBRIAN ROCKS, UNDIFFERENTIATED. (MAINLY METAMORPHIC AND IGNEOUS ROCKS)

BEDROCK GEOLOGY OF GREAT LAKES AREA

FIGURE 3

300-


LAKE ONTARIO
NY
PENN.
LEGEND
▨ OLD LAKE DEPOSIT, PRIMARILY SILT AND CLAY
▥ GLACIAL DRIFT, CLAY WITH INCLUDED GRAVEL
WATER-LAID GLACIAL MORAINE; MAINLY SAND AND GRAVEL
o-o LAND-LAID GLACIAL MORAINE; CLAY, SAND AND GRAVEL
OUTWASH SAND AND GRAVEL
OHIO
PENN.
LAKE ERIE
SCALE IN MILES
10 0 10 20 30 40 50
ONT.
LAKE HURON
LAKE ST CLAIR
MICH
OHIO
OHIO
IND
N

SURFACE GEOLOGY
LAKE ERIE BASIN

FIGURE 4

Lake Erie's shores are characterized by easily eroded banks of glacial till and not much sand. Bluffs of limestone or shale bedrock exist in the islands area, between Vermilion and Cleveland, Ohio, and around the eastern end of the lake. Good sand beaches are few in number, but where developed, are built to the extreme. Examples are Long Point, Pointe aux Pins, and Point Pelee, Ontario; Cedar Point, Ohio; and Presque Isle, Pennsylvania. The till and lake clay bluffs recede by erosion at rates up to 5 or more feet per year, contributing an average of 16 million tons of sediment annually to the lake.

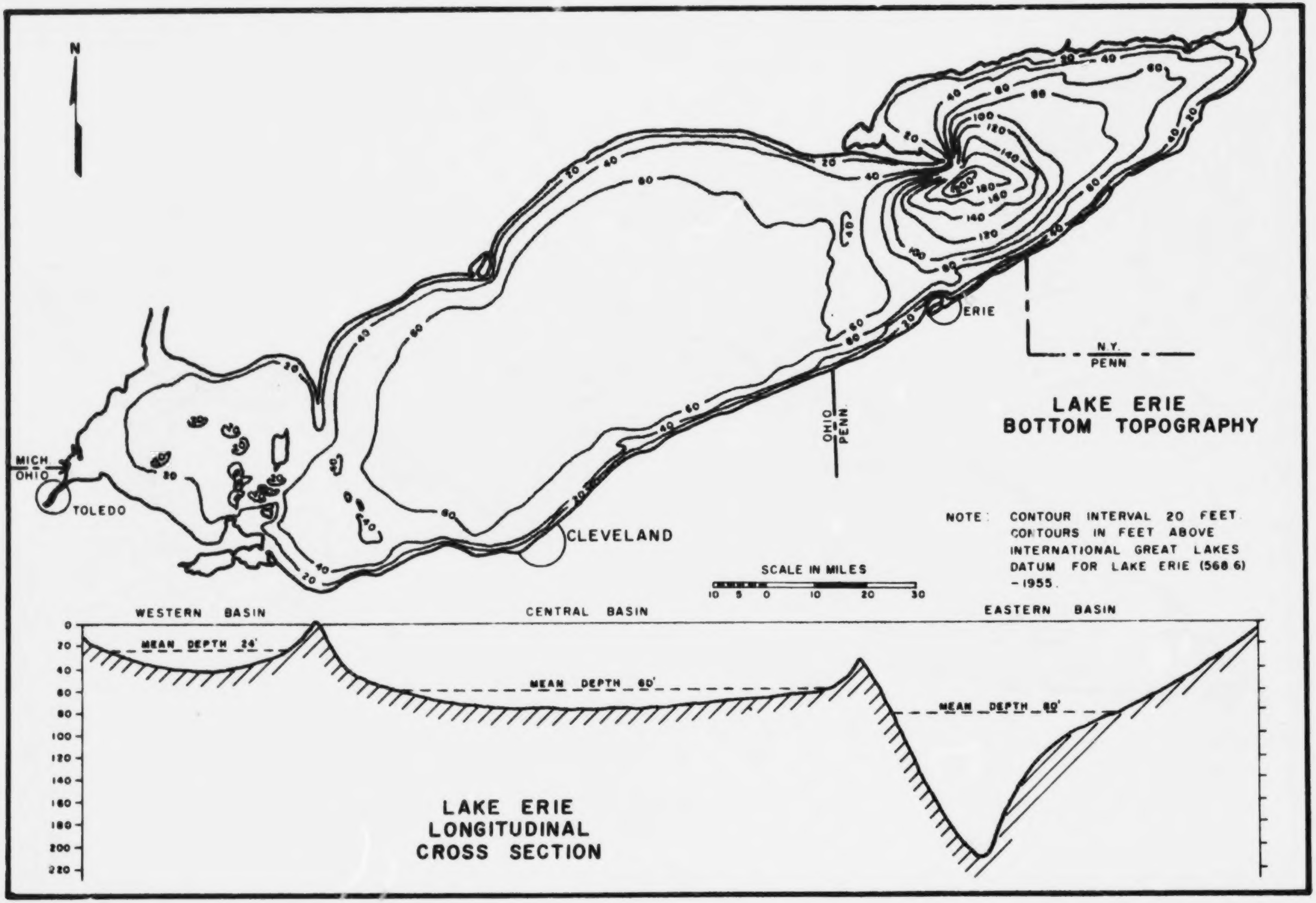
Topographically, Lake Erie is separated into three basins, Figure 5. The relatively small shallow western basin is separated from the large, somewhat deeper, flat-bottomed central basin by the rocky island chain. The deep, bowl-shaped eastern basin is separated from the central basin by a low, wide sand and gravel ridge near Erie, Pennsylvania. The western basin averages 24 feet deep with a maximum of 63 feet in South Passage; the central basin averages 60 feet with a maximum of 80 feet; the eastern basin averages 80 feet with a maximum of 216 feet. The areas of the western, central, and eastern basins are approximately 1,200, 6,300, and 2,400 square miles, respectively.

The bottom sediments of Lake Erie show patterns closely related to topography and relief, Figure 6. In general, the broad, remarkably flat areas of the western and central basins and the deeper, smoother part of the eastern basin have mud bottoms and are the recipients of nearly all of the sedimentation in Lake Erie. Ridges and shoreward-rising slopes are generally comprised of sand and gravel and are characterized by either erosion or the deposition of coarse sediments. Rock is exposed in the western basin and in strips along shores in the central and eastern basins.

GEOLOGY

It is generally believed that the antecedent of Lake Erie, prior to the Ice Age (Pleistocene Epoch), was a major stream valley essentially along the long axis of the present lake. The land topography, although showing slightly more relief, was probably not far different than that of today. The drainage or river system was controlled by differential bedrock resistance and large-scale rock structural features. Bedrock nearest the surface, as it is today, was comprised of shales and limestones and some sandstone, laid down, long before, in epicontinental seas.

The glacial history of the Great Lakes basin is described in detail by Hough (1958) and by Leverett and Taylor (1915). Glaciation by continental ice sheets began on the North American continent approximately one million years ago, representing the beginning of the Pleistocene Epoch of geologic history. Four great ice invasions, named the



LAKE ERIE
BOTTOM TOPOGRAPHY

NOTE: CONTOUR INTERVAL 20 FEET. CONTOURS IN FEET ABOVE INTERNATIONAL GREAT LAKES DATUM FOR LAKE ERIE (568.6) -1955.

LAKE ERIE
LONGITUDINAL
CROSS SECTION

N
MICH
OHIO
TOLEDO
CLEVELAND
ERIE
OHIO
PENN
N.Y.
PENN
SCALE IN MILES
10 5 0 10 20 30
20
40
60
80
100
120
140
160
180
200
WESTERN BASIN
CENTRAL BASIN
EASTERN BASIN
MEAN DEPTH 24'
MEAN DEPTH 60'
MEAN DEPTH 80'
0
20
40
60
80
100
120
140
160
180
200
220

FIGURE 5

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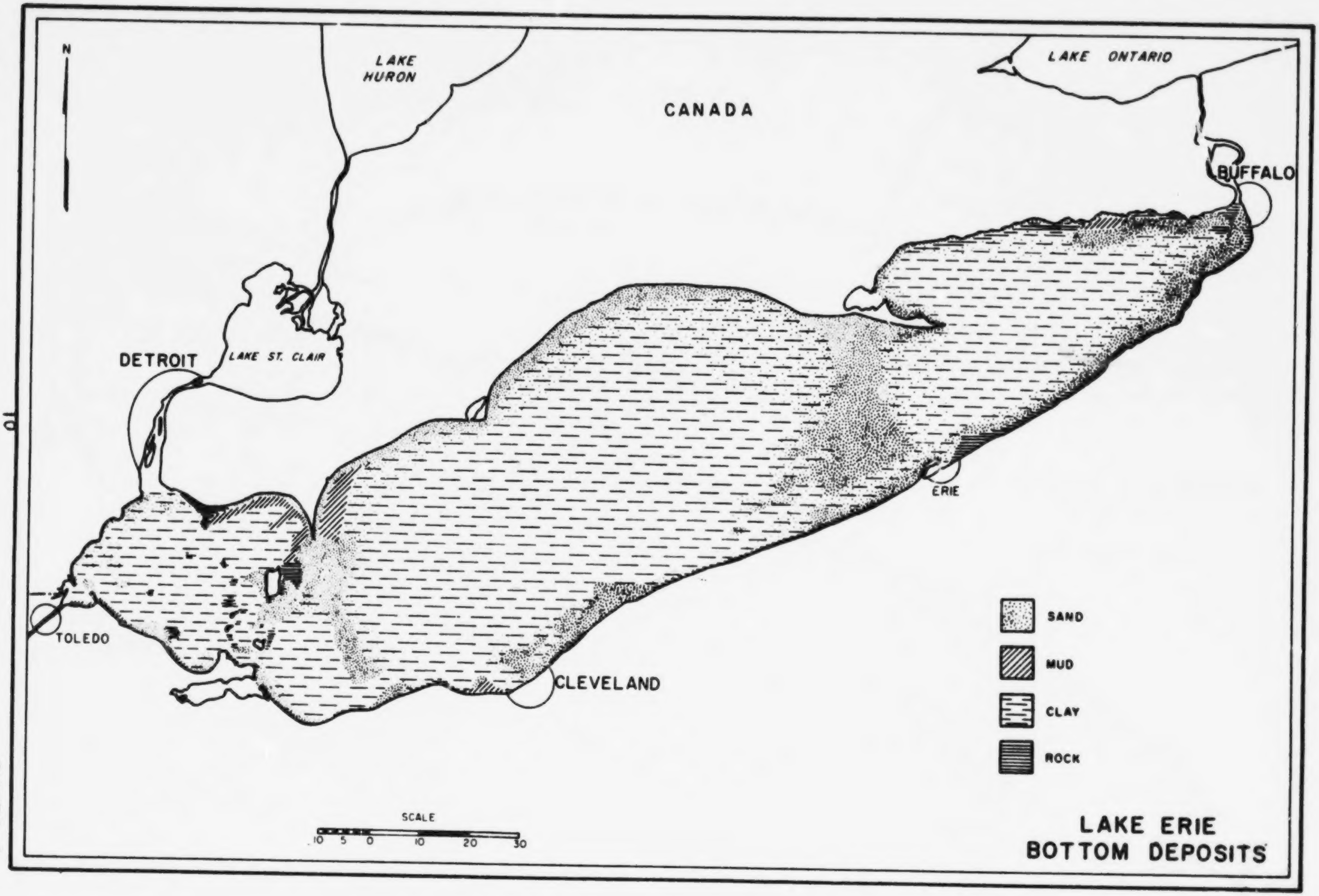

N
LAKE HURON
LAKE ONTARIO
CANADA
BUFFALO
DETROIT
LAKE ST. CLAIR
ERIE
TOLEDO
CLEVELAND
SAND
MUD
CLAY
ROCK
SCALE
10 5 0 10 20 30
LAKE ERIE
BOTTOM DEPOSITS

FIGURE 6

Nebraskan, Kansan, Illinoian, and Wisconsin, characterized this period. Apparently all of these ice sheets covered the Great Lakes region. However, each succeeding invasion obscured or obliterated most of the evidence for the preceding one. In the Lake Erie basin the features produced by Wisconsin glaciation are of the most concern. There are meager remnants of Illinoian glaciation and none of previous activity.

Apparently the Wisconsin ice sheet moved into the Lake Erie basin from the north and northeast about 25,000 years ago. It covered the entire lake area and nearly all of the drainage basin. In western Ohio the ice sheet moved south over flatlands to near the Ohio River while it was stopped by the Appalachian uplands in eastern Ohio, Pennsylvania, and New York.

Upon retreat of the ice sheet, a complex series of glacially-produced features were left behind, most of which resulted from temporary readvances and retreats of the ice front. The features are mainly ground and frontal moraines composed of crushed and reworked local bedrock. A lesser amount of the material is derived from bedrock to the north. This "erratic" material is conspicuous in many places as large crystalline boulders.

Lakes were generally not formed or were very transient features while the ice front was south of the Ohio River-Great Lakes drainage divide. A lake began its existence in the Erie basin when the ice front retreated from a position now represented by a frontal moraine called the Fort Wayne moraine, passing through Fort Wayne, Indiana. This moraine essentially lies along the shoreline of the first glacial lake stage (Lake Maumee) in the Lake Erie basin. The ice still covered what is now Lake Erie, its front lying along the Defiance moraine. The surface of Lake Maumee was at about 800 feet above sea level and the drainage was westward into the Wabash River in Indiana.

Following the Lake Maumee stage was a long series of stages, some draining westward and some eastward. The most significant of these stages are marked by well-developed beach ridges. They were Lake Maumee at 800 feet elevation, Lake Whittlesey at 740 feet, Lake Warren at 690 feet, and Lake Erie at 570 feet. All of these drained westward except for Lake Erie.

One of the most significant points to remember in regard to the history of the Great Lakes is that a lake has occupied the present Lake Erie basin for a much longer time than lakes have existed in the other basins.

The four stages mentioned above were the most important, but there were many intervening stages, not always successively downward, in the Erie basin, controlled by relatively minor retreats and advances of the ice front. Significant in this regard is the fact that ice occupied the eastern end of Lake Erie several times, possibly accounting for the present relative deepness of that part of the basin.

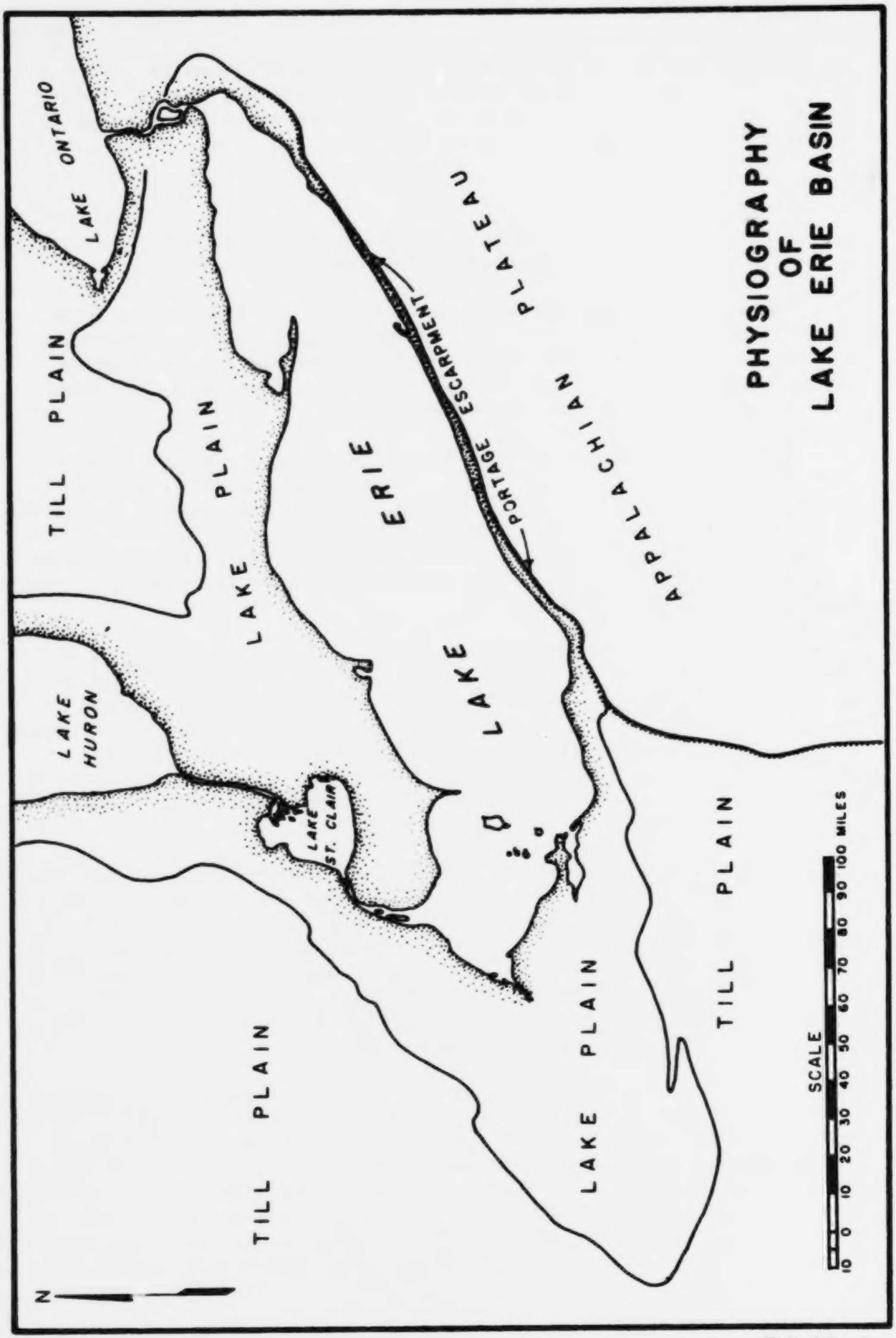
The water level in the Erie basin has not always been at its present level or higher. At least two stages have been considerably lower and did not receive drainage from the upper lakes. Both these stages have occurred in the last 11,000 years. The first one of importance was some 80 feet lower than the present lake. The lake then rose by ice damming and uplift to a level of 100 feet above the present lake. Ice retreat dropped the level again to 40 feet below the present lake. That stage was the immediate predecessor of Lake Erie as we know it today. The lake then began to rise (about 4,000 years ago) to its present level by uplift of the Niagara outlet; that rise continues today.

The differential resistance of the bedrock (see Figure 3) to glacial abrasion was responsible for a major part of Lake Erie's present form (Carman, 1946). The islands and headlands of western Lake Erie are remnants of resistant limestone and dolomite. Resistance also accounts in part for the shallow water depths in the west end of the lake. The broad flat central part of the lake lies along the strike of a broad band of uniformly resistant shales bounded on the south shore by similar shales capped by relatively resistant sandstones. The deeper eastern basin is also underlain by shales but has been subject to more abrasion and less, later sedimentation.

The Lake Erie basin lies mainly in the Central Lowlands physiographic province (Figure 7) near where it wedges out between the Appalachian Plateau and Laurentian Upland. The southeastern part of the drainage basin is in the Appalachian Plateau. The boundary between the Central Lowlands and the Appalachian Plateau in the Erie basin is a sharp rise of 200 to 300 feet in elevation called the Portage Escarpment. From Cleveland eastward the escarpment parallels the lake shore and lies generally less than five miles from it. At Cleveland the escarpment turns southward across Ohio.

The part of the Central Lowlands in the Lake Erie basin is called the Lake Plain and is for the most part the very flat former lake bottom. East of Cleveland it is narrow and lies between the Portage Escarpment and the present lake shore. West of Cleveland it widens quickly and in western Ohio it is more than 50 miles wide. It narrows again in Michigan to about 20 miles wide. In Canada it is 20 to 30 miles wide but is not so well defined because of the complexity of glacial features. The lake plain is characteristically low and comprised of poorly drained silt and clay with occasional sandy ridges formed as beaches and bars in older lakes.

The streams (except the Detroit River) entering Lake Erie originate either within or just outside the boundaries of the Lake Plain.


LAKE ONTARIO
TILL PLAIN
LAKE PLAIN
LAKE ERIE
PORTAGE ESCARPMENT
APPALACHIAN PLATEAU
LAKE HURON
LAKE ST. CLAIR
TILL PLAIN
LAKE PLAIN
TILL PLAIN
SCALE
10 0 10 20 30 40 50 60 70 80 90 100 MILES
N

PHYSIOGRAPHY OF LAKE ERIE BASIN

FIGURE 7

The valleys are generally narrow and winding with steep to vertical walls. The shapes indicate that most of the valleys are in a youthful stage of maturity, having been cut rapidly since the Ice Age in a flat region but high relative to the lake.

CLIMATE

The climate of the Lake Erie basin is temperate, humid-continental with the chief characteristic of rapidly changing weather.

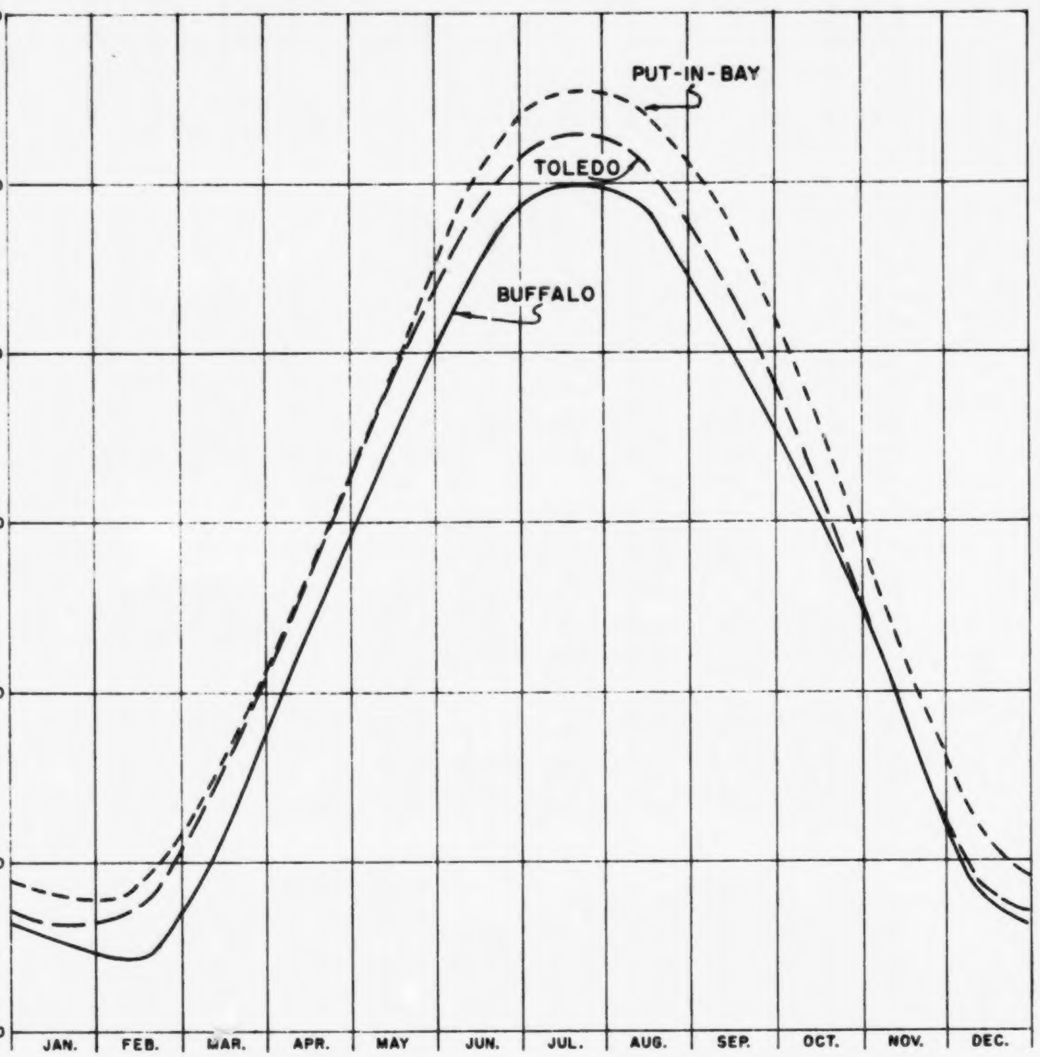
The annual average temperatures for land stations in the Erie basin range between 47°F and 50°F. Temperatures generally decrease northeastward from the southwestern end of the basin. The highest average temperature at recording stations is at Put-in-Bay on South Bass Island with an annual average of 51.2°F.

The highest average monthly temperatures occur in July, ranging from 70°F to 74°F at land stations. These also generally decrease northeastward across the basin, Figure 8. Put-in-Bay again is highest at 75.1°F. The lowest average monthly temperatures occur in January at the west end of the basin and February at the east end, and range from 24°F to 28°F. The extremes of temperature in the Lake Erie basin are about -20°F and 100°F.

Average annual precipitation at land stations in the basin is well-distributed throughout the year, Figure 9, and ranges from about 30.5 inches to more than 40 inches with an overall basin average of about 34 inches. Yearly precipitation has varied between the extremes of 24 and 43 inches. Precipitation shows a striking correlation to land elevation and topography, Figure 10. Low-lying flat areas of the basin have the lowest precipitation. Highest precipitation occurs in the southeastern part of the basin.

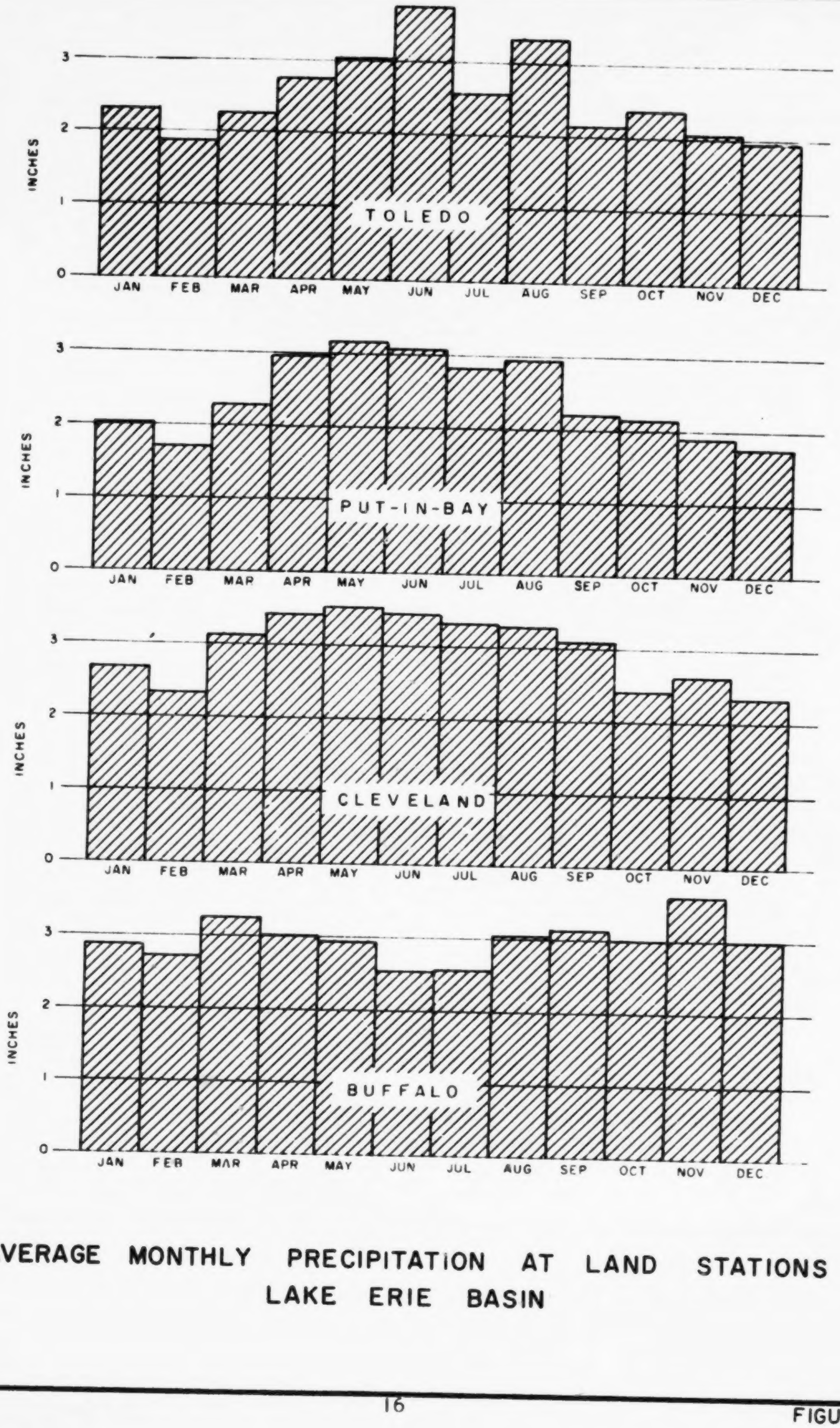
Most of the precipitation in the Lake Erie basin is derived from the flow northeastward of warm, moisture-laden air of low pressure systems from the Gulf of Mexico. Precipitation results when this clashes with colder, northern air of high pressure systems, moving in from the west and northwest. This kind of weather is characteristic of spring, summer, and early fall, and usually occurs in cycles of a few days. Humidity is high along with high temperatures, and south to southwest winds persist for long periods.

In winter, however, the colder Canadian air masses push southeastward and dominate the weather, resulting in less precipitation and less humidity. Heavier precipitation (usually snow) is experienced in the southeastern part of the basin, explaining the shift in the annual precipitation pattern in that area. This phenomenon is largely local, caused by air moving across Lake Erie, picking up moisture enroute, and precipitating it when the air rises along the front of the hills on the southeastern shore. Snowfall is greater in the eastern



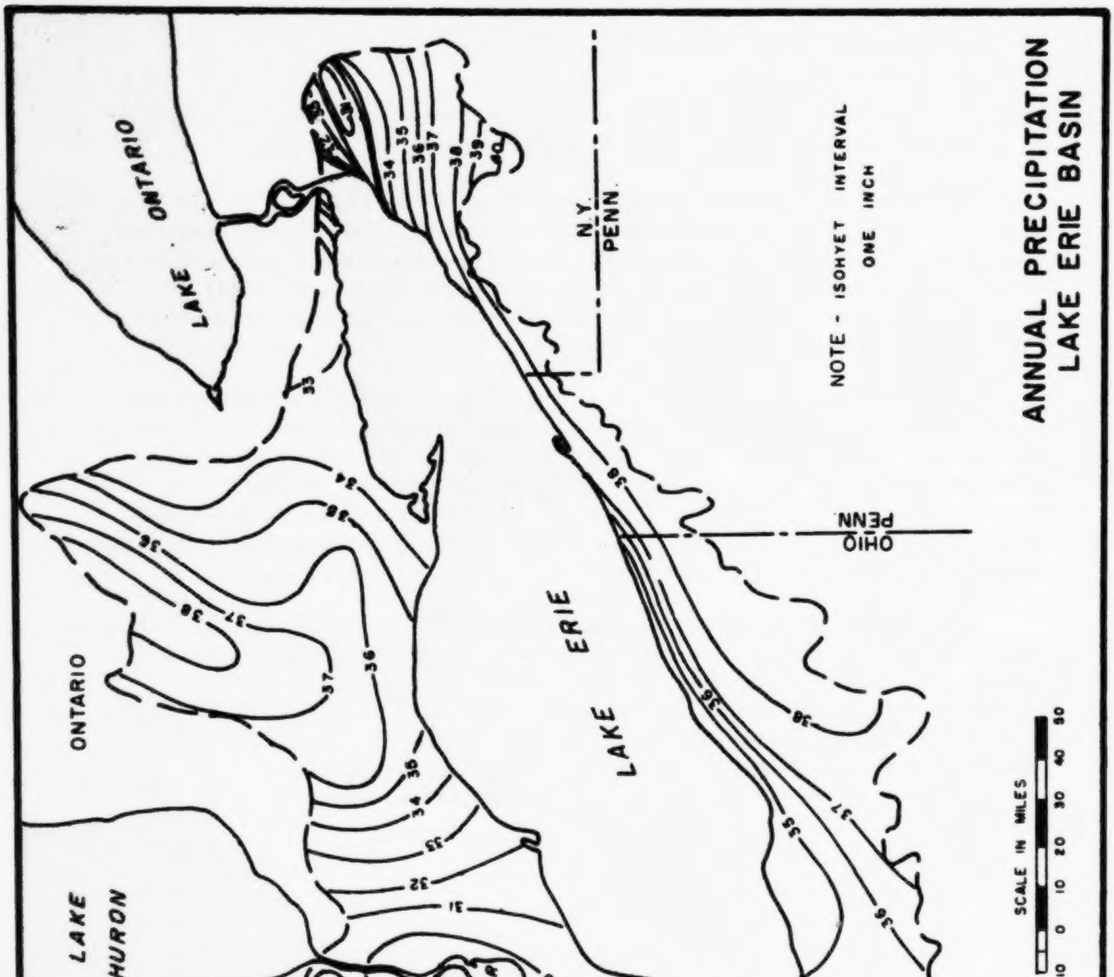
ANNUAL AIR TEMPERATURE CURVES FOR TOLEDO, PUT-IN-BAY AND BUFFALO

FIGURE 8



AVERAGE MONTHLY PRECIPITATION AT LAND STATIONS
LAKE ERIE BASIN

FIGURE 9


LAKE ONTARIO
N.Y.
PENN.
NOTE - ISOHYET INTERVAL ONE INCH
OHIO
PENN.
LAKE ERIE
ONTARIO
LAKE HURON
LAKE ST. CLAIR
MICH.
OHIO
IND
OHIO
SCALE IN MILES
10 0 10 20 30 40 50
N
30
31
32
33
34
35
36
37
38
39
40

ANNUAL PRECIPITATION
LAKE ERIE BASIN

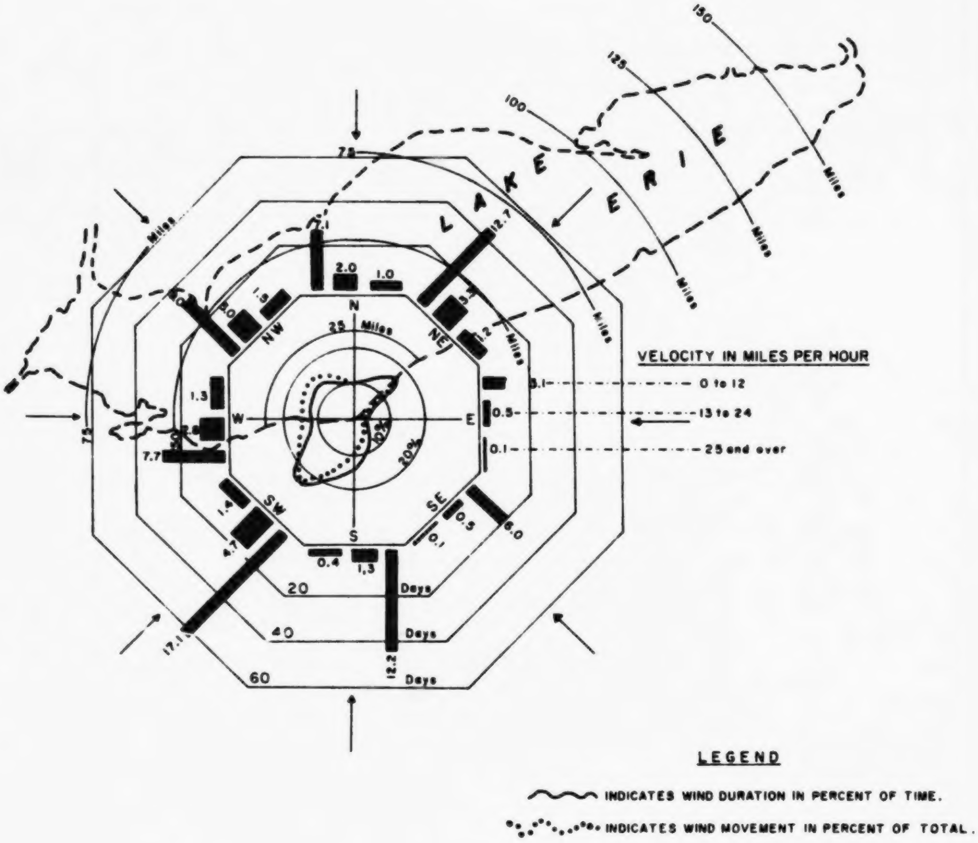
FIGURE 10

part of the basin with Buffalo having an annual average snowfall of 72 inches, as compared to less than 36 inches for Toledo.

Southwesterly winds prevail over Lake Erie (Figure 11) in all months of the year, a characteristic common to the northern hemisphere temperate region. However, in fall and winter, northwesterly winds occur frequently, reaching high velocities (40-50 mph) in storms. In spring the same is true of northeasterly winds except that velocities (30-40 mph) are usually lower.

The percent of possible sunshine is greatest in midsummer and least in winter, Figure 12, although precipitation might indicate otherwise. Less sunshine in winter is due to the cloud-producing effects of the lake. December and January ordinarily have less than 40 percent of possible sunshine, while June and July average more than 70 percent at most stations. The percentage over the lake proper in summer is even greater.

Lake Erie has a marked moderating effect on the climate of the basin, especially for a few miles inland from the shore. This is demonstrated by the length of the frost-free season - near shore it is greater than 200 days, while only a few miles inland it is as much as 30 days less. This longer frost-free season is due to a warming effect from the lake water. During the late fall and early winter the lake water is still relatively warm and delays the first killing frost.



NOTES:

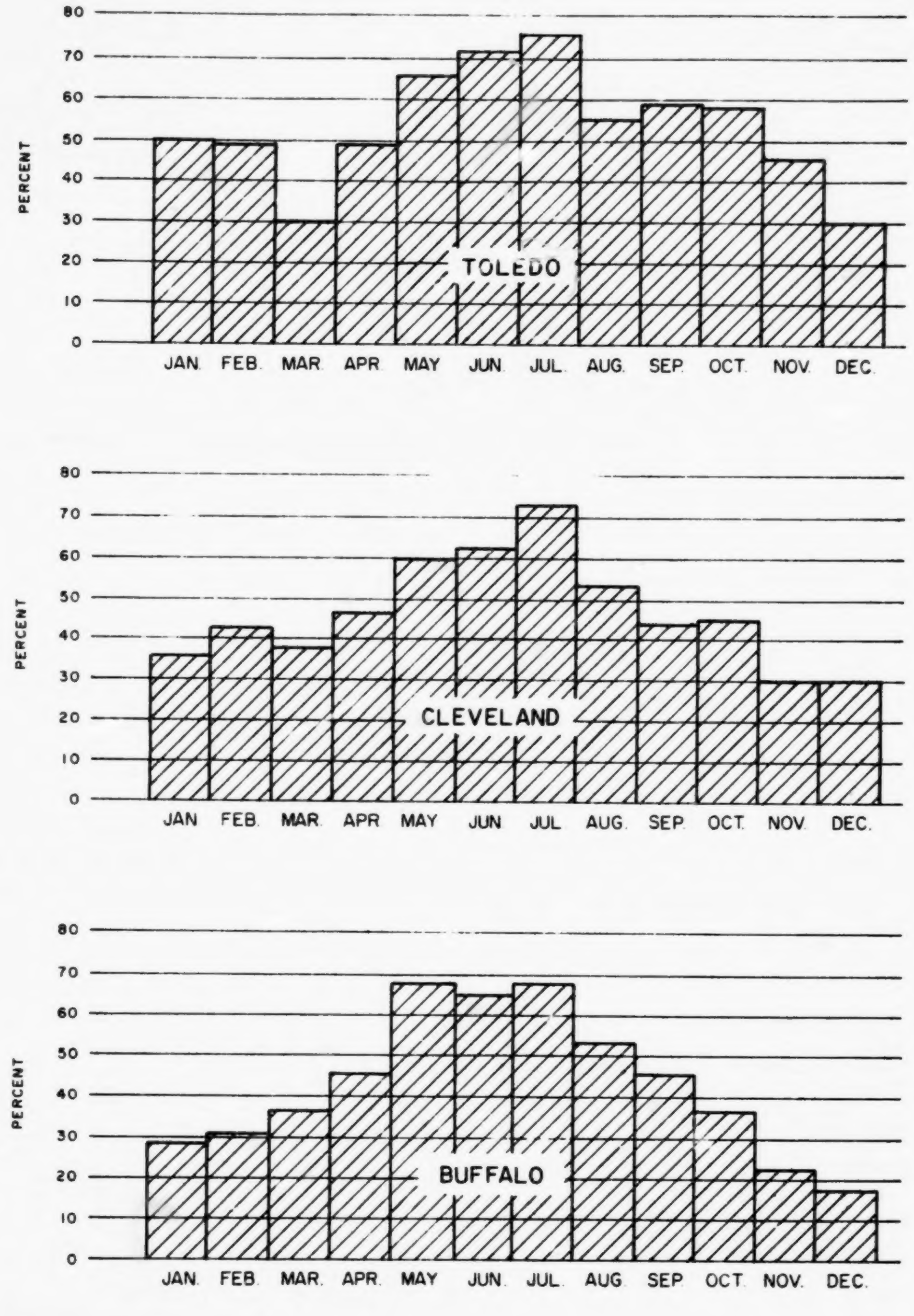
Figures at the end of bars indicate average yearly percentage of occurrence of wind in the direction and velocity shown.

Length of bar denotes duration in average days per year.

Wind data from logs of the U. S. Coast Guard, Cleveland, Ohio.

WIND DIAGRAM FOR CLEVELAND, OHIO

FIGURE 11



MONTHLY PERCENT OF POSSIBLE SUNSHINE 1965

FIGURE 12

CHAPTER 2

LAKE ERIE PHYSICAL CHARACTERISTICS

LAKE BOTTOM

Each of the three basins of Lake Erie contain unique physical features. Because of this, each basin will be described separately in some detail. Much of the description is taken from U. S. Lake Survey and Ohio Division of Geological Survey publications.

WESTERN BASIN

The western basin of Lake Erie is that part of the lake west of a line from Point Pelee through Kelleys Island to Marblehead, Ohio (Figure 1). Its long orientation is west-northwest, at an angle to the main east-northeast orientation of Lake Erie. The basin averages 24.5 feet in depth and covers an area of approximately 1,200 square miles. On its western and southern sides the bottom slopes gently from shore out to the 24-foot depth, five to ten miles offshore. On the north side of the basin the nearshore slope is steeper, the 24-foot depth being only one-half to two miles offshore (Figure 5). Beyond the 24-foot depth the bottom is very flat, reaching a maximum depth of only about 35 feet west of the Bass Islands. The flat bottom is generally mud, interrupted locally by small reefs and islands of rock, such as Niagara Reef, West Sister, and Middle Sister Islands (Figure 1).

The inter-island bottom, also mud, has considerably more relief, but much of it, too, is very flat. Depths are generally in the same range as those west of the islands. Within the more restricted channels, depths are considerably greater, due to current scour. The deepest of these are south of South Bass Island at 63 feet and north of Kelleys Island at 52 feet.

Reefs of bedrock are common around the islands. They generally have rough surfaces and steep slopes and rise to near or above lake level. Most of the rock exposures lie in two bands, one from Marblehead through Pelee Island, and the other from Catawba through the Bass Islands. Bedrock under the basin is fairly rough and in places is 80 feet or more beneath the lake bottom (Hartley, 1961). These depressions are filled with lake sediments.

Hard clay bottom is found in a narrow strip along the south shore and in a broader band near the northeastern shore of the western basin (Verber, 1957).

Sand and gravel are not abundant in western Lake Erie. Most of that which exists is found on beaches along the mainland shores, in a relatively large area off Locust Point, Ohio, across the mouth of Maumee Bay, and in the northern half of the eastern island chain (Figure 6).

Beach, bank, and nearshore bottom erosion is prevalent and in many places is a very serious problem especially in the Toledo area.

The shore banks around the western basin are mainly clay. Their height is less than 10 feet above lake level on the south shore. Dikes and swampland are common. On the north shore the banks rise to 30 feet or more above the lake. Rock bluffs, up to 30 feet high, are found on the islands and the Catawba and Marblehead peninsulas.

CENTRAL BASIN

The central basin of Lake Erie extends from the islands eastward to the sand and gravel bar crossing the lake between Erie, Pennsylvania and Long Point, Ontario (Figures 1 and 6). The top of the bar is 40 to 50 feet below water level. The central basin has an area of about 6,300 square miles, an average depth of 60 feet, and a maximum depth of 80 feet. Approximately 75 percent of the central basin is between 60 and 80 feet deep.

The bottom of central Lake Erie is extremely flat over most of its area (Figure 5). The only relief features of any consequence are the shoreward-rising slopes of sand, gravel, and rock, and a low wide bar extending south-southeastward from Point Pelee, Ontario to near Lorain, Ohio. This bar is two to six miles wide and rises 15 to 20 feet above the general lake bottom. It separates a small, triangle-shaped, flat-bottomed basin with 40 to 50-foot depths from the main part of the central basin to the east. This small basin and the main basin have mud bottoms and are connected by a broad channel near the Ohio shore.

The mud, which covers more than two-thirds of the central Lake Erie bottom is generally dark gray in color and contains very little coarse material. In mid-lake it is similar in physical appearance for several feet downward from the surface (Hartley, 1961).

Sand and gravel are found on the bottom in a strip of varying width along the north and south shores of the basin. It reaches its greatest width of five miles or more between Cleveland and Fairport, Ohio.

Limestone and dolomite bedrock are found on the bottom at the extreme western end of the basin. Shale is exposed as a narrow strip discontinuously from Vermilion eastward along and very near the south shore. Otherwise bedrock does not reach the lake bottom surface in the central basin. At some places it is known to be more than 100 feet under the lake bottom.

Natural beaches are generally narrow to nonexistent along the south shore of central Lake Erie and along most of the north shore. The Cedar Point spit on the south shore and the spits at Pelee Point and Pointe Aux Pins on the north shore are exceptions. Harbor structures, such as those at Huron, Fairport, Ashtabula, and Conneaut on the south shore have created exceptional artificial beaches but have caused shore erosion problems on the down-drift sides (Hartley, 1964).

The north and south shores of the central basin are generally characterized by eroding banks of glacial till and lake-deposited silt and clay. On the south shore the banks rise in height from less than 30 feet near the west end to more than 70 feet at the east end of the basin. On the north shore they rise similarly to more than 100 feet at the east end. Rock bluffs are limited to shore stretches between Vermilion and Cleveland, Ohio. Rapid erosion of the shore banks has contributed a great amount of sediment to the central basin.

Rivers and streams emptying into the central basin are small and ordinarily provide an insignificant amount to the lake's water supply. In the past, however, they have contributed a very large amount to lake sediments.

The water of the central basin of Lake Erie is generally less turbid than that of the western basin because the basin is larger and deeper, and streams do not carry great loads of sediment. The western end of Lake Erie acts as a settling basin for most of the water supply to the central basin.

EASTERN BASIN

The eastern basin is that part of Lake Erie lying east of the bar between Erie, Pennsylvania and Long Point, Ontario (Figure 1 and Figure 5). It has an area of approximately 2,400 square miles and an average depth of about 80 feet. It is by far the deepest part of Lake Erie with a maximum depth of 216 feet (U. S. Lake Survey Chart No. 3).

The bottom of the eastern basin is relatively smooth but not flat like the western and central basins. Most of the bottom is mud (Figure 6) and is generally lighter-colored and more compact than that in the other two basins.

The eastern basin is bounded on the west and south and around the east end by relatively steep slopes on sand and gravel. Rock is exposed in a strip along both the north and south shores. As in most of

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Lake Erie the beaches are generally narrow or absent with two notable exceptions. Presque Isle, Pennsylvania and the massive spit at Long Point, Ontario, are large natural accumulations of sand, together accounting for a large part of the beach sand in Lake Erie. Both of these spits have enclosed rather large shallow bays.

Rocky bluffs are found along most of the shore of the eastern basin with shale on the south shore and limestone on the north shore.

Rivers and streams entering the eastern basin are unimportant to the water supply of the lake even though the Grand River in Ontario supplies more than 2,000 cfs. The streams have been relatively small contributors of sediments.

The water in the eastern basin is clear compared to the remainder of Lake Erie. The shores are very resistant to erosion, sediment-laden streams are virtually nonexistent, and the water is much deeper, thereby minimizing wave agitation of bottom sediments. Also the central basin is a settling basin for nearly all of the eastern basin's water supply.

LAKE WATER

TRIBUTARY SUPPLY

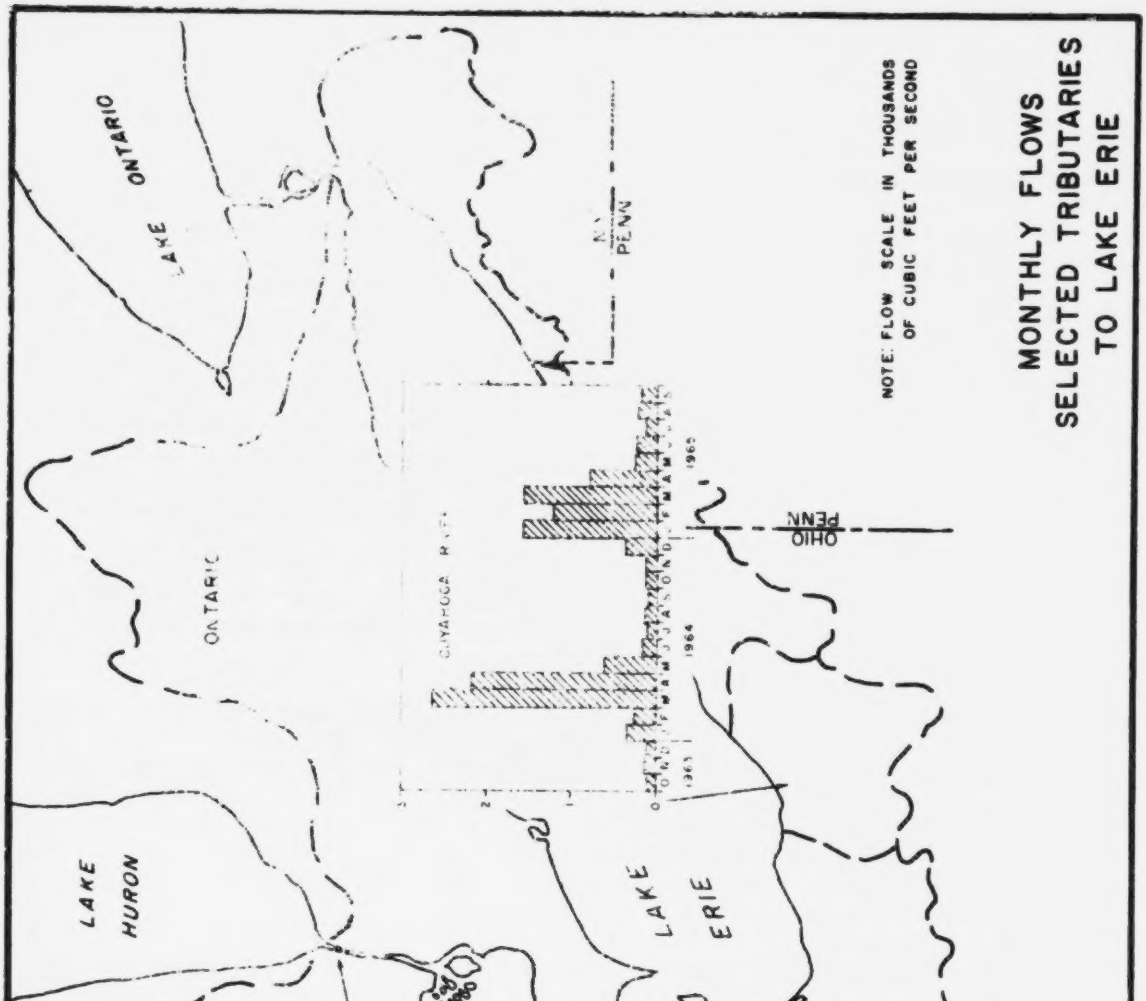
LAKE HURON OUTFLOW

Lake Erie receives 80 percent of its water supply from upper lake drainage. The large volume and high quality of this inflow have a great dilutional effect on Lake Erie, and any significant decrease in either the volume or quality could be disastrous.

The Lake Huron outflow is the only source of water to Lake Erie which is not controlled by precipitation over the Erie basin, being controlled instead by precipitation in the basins of Lakes Superior, Michigan, and Huron. Diversion out of Lake Michigan at Chicago, diversion into Lake Superior, and flow regulation from Lake Superior affect to a minor degree the Lake Huron discharge.

According to U. S. Lake Survey measurements, the Lake Huron outflow has averaged 187,450 cfs between 1860 and the present. The monthly averages have ranged from a high of 242,000 cfs in June 1896 to a low of 99,000 cfs in February 1942. Lowest flows ordinarily occur in February (average 159,000 cfs) and the highest in July or August (average 199,000 cfs), Figure 13. Other tributary runoff to Lake Erie is generally at a minimum during periods of high Lake Huron outflow.

Though the variation in flow volume from Lake Huron is great, it is still the most uniform of the tributary drainages to Lake Erie.


LAKE ONTARIO
ONTARIO
LAKE HURON
LAKE ERIE
N.Y.
PENN
OHIO
PENN
IND
OHIO
ST CLAIR RIVER
180
170
160
150
140
130
120
1963
1964
1965
MAUMEE RIVER
0
2
4
6
8
10
12
14
16
18
O N D J F M A M J J A S O N D J F M A M J J A S
1963
1964
1965
CUYAHOGA RIVER
0
1
2
3
O N D J F M A M J J A S O N D J F M A M J J A S
1963
1964
1965

NOTE: FLOW SCALE IN THOUSANDS OF CUBIC FEET PER SECOND

MONTHLY FLOWS SELECTED TRIBUTARIES TO LAKE ERIE

FIGURE 13

This is because of the regulating effect of the upper lakes storage.

MAJOR TRIBUTARIES

Only four Lake Erie tributaries beside the Lake Huron outflow, exceed an average discharge of 1,000 cfs to Lake Erie. These are the Maumee and Sandusky Rivers in Ohio and the Grand and Thames Rivers in Ontario, Table 2. The Thames discharges to Lake St. Clair. These rivers supply a total flow of approximately 10,000 cfs - the Maumee River accounting for about one-half of this.

All four major tributaries drain land which is largely agricultural and rather intensively cultivated. Precipitation on the Grand and Thames basins is slightly higher than on the Maumee and Sandusky basins, Figure 10. However, the percentage of precipitation appearing as unoff is considerably greater in the Canadian basins, 36 percent compared to 28 percent, the difference being accounted for in topography and soil characteristics. The average water yield per square mile is just over 0.7 cfs in the Maumee and Sandusky River basins, and over 0.9 cfs for the Grand and Thames River basins.

Drough flows are very low for the Maumee and Sandusky Rivers. Seven-day, 10-year recurrence low flows are estimated at 86 cfs and 14 cfs, respectively, at the mouths of these streams. Drought flows of the Grand and Thames Rivers appear to be much higher per unit area, indicating that ground water is significant in contributing to those flows. The low ground water contribution in the Maumee and Sandusky basins can be attributed to the relatively flat topography and to the dense and relatively impermeable clay soils.

In many upstream locations there is virtually no flow during the critical low flow, high temperature, high evaporation months of July through October. Flow is also low and time of travel is long near most stream mouths. For example; in the lower several miles of the Maumee River the flow volume is low, the cross-sectional area of the river is large, and the gradient is virtually nil. This results in a very long time for water to travel through the Toledo area - frequently a month or more. A similar situation, but less severe, exists in the lower several miles of the Sandusky River. At other localities in both basins, time of travel is lengthened by pooling effects of both natural and artificial features.

MINOR TRIBUTARIES

All other tributaries to Lake Erie contribute only minor water flow to the lake. The more important of the minor tributaries, with pertinent hydrologic data, are listed in Table 2. These streams have average flows between 200 and 900 cfs.

TABLE 2

RUNOFF STATISTICS FOR TRIBUTARIES OF THE LAKE ERIE BASIN

Stream	Drainage Area (mi.^{2})	Period of Record (years)	Max. Flow (cfs)	Min. Flow (cfs)	Average Flow (cfs)	Average Yield (cfs/mi.^{2})	7-Day Low Flow, 10 yr. Recurrence (cfs/mi.^{2})	7-Day Low Flow, 10 yr. Recurrence (cfs at mouth)*	Runoff Precip. %
St. Clair River (Lake Huron outflow)		106			187,450				
Clinton River	740	31	21,200	---	470	.635	.052	24	28
Rouge River	467	35	13,000	1.8	235	.503	.033	7.8	22
Huron River (Mich.)	890	19	5,840	4.0	556	.625	.044	24	27
Raisin River	1,125	28	12,900	2.0	714	.635	.027	19.3	28
Maumee River	6,586	40	94,000	20.0	4,794	.728	.013	86	29
Portage River	587	33	11,500	0.3	403	.687	.001	0.6	28
Sandusky River	1,421	39	28,000	4.4	1,021	.719	.010	14.0	28
Huron River (Ohio)	403	15	25,800	2.2	296	.732	---	5.1±	28
Vermilion River	272	15	20,500	0.0	228	.840	---	0.6±	33
Black River	467	21	24,000	0.0	302	.647	---	0.5±	29
Rocky River	294	34	21,400	0.2	273	.929	.004	1.0	35
Cuyahoga River	813	34	24,800	14.0	850	1.045	---	112	39
Chagrin River	267	36	28,000	3.0	333	1.247	.051	4.0	46
Grand River (Ohio)	712	40	21,100	0.0	784	1.101	.003	2.2	40
Ashtabula River	137	34	11,600	0.0	169	1.234	.000	0.0	45
Conneaut Creek	191	28	17,000	0.2	257	1.346	.006	1.2	49
Cattaraugus Creek	436	25	35,900	6.0	705	1.617	.129	55	58
Buffalo River	565	25	35,000	2.8	784	1.388			55
Grand River (Ont.)	2,614	24	47,800	65.0	2,405	.920			36
Big Creek	281	7	3,060	54.0	256	.911			35
Otter Creek	316	13	4,140	10.8	312	.987			37
Kettle Creek	200±	-	2,400±	7±	185±	.902			34
Thames River	2,000±	7	38,500±	58	1,840	.902			36

* All except Cuyahoga River and Cattaraugus Creek do not include all flows from STPs below or above gaging station.

The Portage and Raisin Rivers are similar in most characteristics to the Sandusky and Maumee Rivers except for much lower average flows. The minor tributaries in Ontario are also similar to the Grand and Thames Rivers.

The Huron River in Ohio is similar to the Sandusky in flow characteristics except that it has a higher base flow per unit area and its basin is partly in higher land, approaching the hilly section of the lake watershed. Ground water appears to be more important as a part of this stream supply.

From the Huron (Ohio) basin eastward along the Ohio shore, precipitation generally increases (Figure 10) and a greater share of the precipitation reaches the lake as runoff (Table 2). Drought flows are, however, widely variable and again reflect the ability of ground water to support stream flow. In addition, these streams have higher gradients and runoff is much faster. The upstream reaches of most of these streams may be completely dry during much of the summer-fall low flow period.

All of the streams along the south shore become sluggish in the lower few miles, a characteristic accentuated by the harbor enlargement of stream cross-section. The time-of-travel in the dredged channels is often a week or more. The 7-day low flow volume for the Cuyahoga River (Table 2) is relatively high, due to impoundments and large waste water discharges to the river, rather than ground water supply.

The important minor tributaries in Michigan are the Clinton, Rouge, Huron, and Raisin Rivers. The Clinton discharges into Lake St. Clair, the Rouge into the Detroit River, and the Huron and Raisin directly into Lake Erie. All are highly polluted streams, passing through the urbanized and industrialized area of southeast Michigan. They all drain relatively flat land, and not only is precipitation the lowest, but the proportion of runoff to precipitation is also the lowest in the Lake Erie basin. However, their drought flows are higher than average per unit area, indicating that perhaps there is significant release of ground water or surface storage. The Clinton and Huron are fed by several small natural lakes, but the Rouge and Raisin are not. There are several low-head dams near the mouth of the Raisin River.

The lower few miles of Michigan tributaries are dredged, sluggish, and lake-affected. Time of travel is long and especially long in summer and fall. The streams are similar to the south shore minor tributaries mentioned above in having long time-of-travel characteristics.

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GROUND WATER

Ground water in the soil and rocks surrounding Lake Erie varies widely in both quantity and quality, Figures 14 and 15. Quantity alone is not a good indicator of supply capacity because of differences in retention characteristics of the soil. For example, glacial clays may contain much water, with the water table very near the surface, but their low permeability makes them a poor source of water supply.

Although characteristics vary, the basin as a whole is a rather poor producer of ground water. Tills, lake clays, and shales which are prevalent over much of the basin are not good aquifers - producers of water. Where they do produce significant quantities, it is not uncommon for the water to have a high sulfur content. Locally high quantities of water may be available where deep sandy soils occur as the result of beach-building or glacial outwash, or in old valleys filled with gravelly soils. Porous limestones are also locally good aquifers as are sandstones, but all of these sources, except for sandstones, may contain sulfur.

LAKE WATER BALANCE

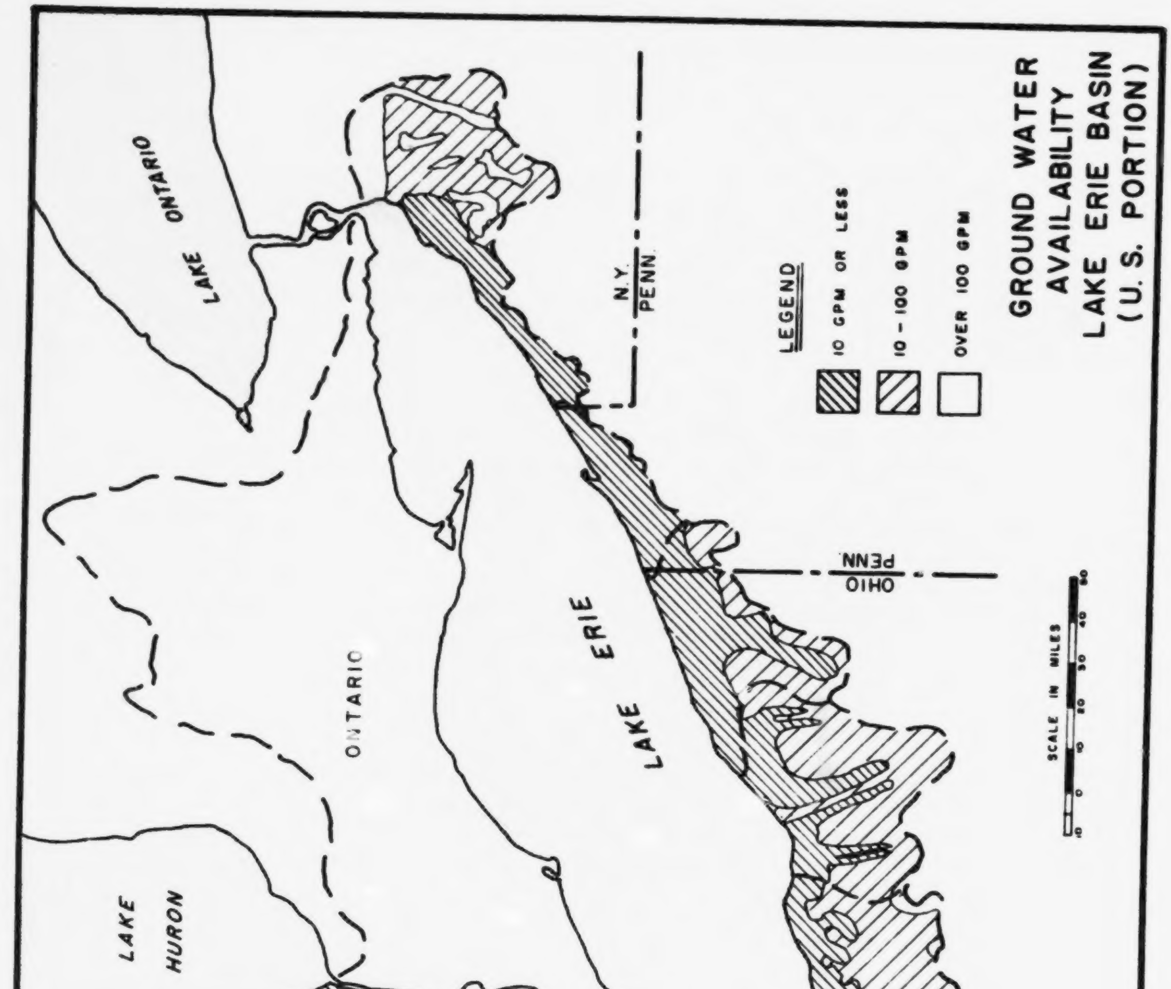
The water balance must be considered in the hydrology of Lake Erie. Because of a lack of precise quantitative information on some of the factors any proposed balance is an estimate and subject to criticism. The factors can be formulated, for a given period, in the equation:

$$P + R + U + I - \pm D - E - O = \Delta S$$

where:

P = precipitation directly on the lake's surface
R = runoff from the lake's land drainage area
U = ground water - considered plus in the aggregate
I = inflow from lake above
O = outflow from lake
D = diversion; plus if into lake, minus if out of lake
E = evaporation from the lake's surface
ΔS = change in amount of water store in the lake; plus if supplies exceed removal, minus if removals exceed supplies

Precipitation (P) on the lake's surface is difficult to measure and must be interpolated from perimeter land precipitation measurements. It is generally considered that over-lake precipitation is less than that over land and precipitation on the lake's surface approximately equals evaporation in the long run. In the balance shown here, the precipitation (29 inches annually) at Put-in-Bay has been used.


LAKE ONTARIO
N.Y.
PENN.
OHIO
PENN.
ONTARIO
LAKE ERIE
LAKE HURON
LAKE ST CLAIR
MICH.
OHIO
IND
OHIO
N
LEGEND
▨ 10 GPM OR LESS
▨ 10 - 100 GPM
☐ OVER 100 GPM
SCALE IN MILES
10
0
10
20
30
40
50

GROUND WATER AVAILABILITY LAKE ERIE BASIN (U.S. PORTION)

FIGURE 14

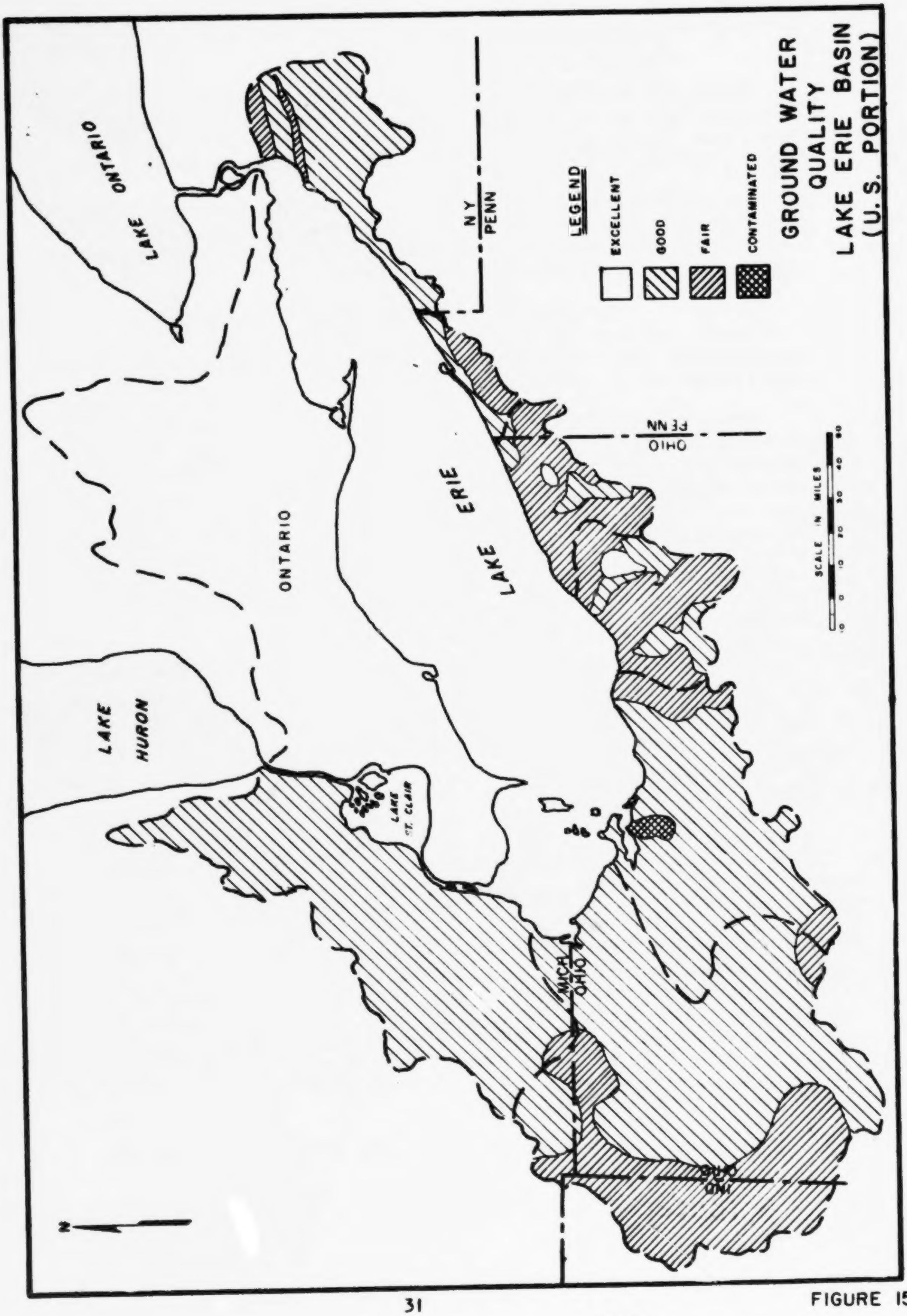

GROUND WATER
QUALITY
LAKE ERIE BASIN
(U.S. PORTION)
LEGEND
☐ EXCELLENT
▨ GOOD
▨ FAIR
▩ CONTAMINATED
SCALE IN MILES
10 0 10 20 30 40 50
LAKE ONTARIO
LAKE HURON
ONTARIO
LAKE ERIE
LAKE ST. CLAIR
NY
PENN
OHIO
PENN
MICH
OHIO
OHIO
IND
N

FIGURE 15

Runoff (R) is measurable to a degree by stream gaging but is highly variable due to areal differences in precipitation, topography, soil type, and vegetation. Runoff is estimated by applying factors, derived from stream gaging, to stream drainage basin areas.

The ground water contribution (U) is virtually unknown, is not directly measurable, and is usually considered negligible in lake water budget computations. It is regarded as positive in the equation, although it may actually be a negative factor.

Inflow (I) from the lake above and natural outflow (O) are not difficult to measure, and the U. S. Lake Survey has done this for more than 100 years. The measurements are considered reliable and adequate for balance calculations.

Diversion (D) in Lake Erie is of two kinds, diversion out of the basin and consumptive, or transient, use within the basin. Water is diverted out of the basin as a supply for the Welland Ship Canal. In the balance, the U. S. Lake Survey estimate of 7,000 cfs annually has been used. Within the basin, water is diverted for man's use out of and back into the lake. A small portion is consumed and not returned in this process. The total consumption is measurable, but in the total lake water balance it is considered negligible. The diversion factor in Lake Erie is always minus. Diversion to the lake from outside the basin is nonexistent.

Evaporation (E) is a net loss from the lake. Its measurement with unquestioned accuracy is not possible with present methods. It is usually calculated by solving the water budget equation for E. This calculation obviously depends upon the accuracy of the other factors. In the balance presented here it has been calculated to be 34.3 inches per year.

Changes in storage (ΔS) are easily measured by recording water levels over the period. Changes in water levels at a particular site induced by factors other than those in the equation; i.e., wind setup, seiches, and tides, are not considered as changes in storage. The long-term change in storage is assumed to be nil for Lake Erie.

A Lake Erie water budget study by Derecki (1964) has been used to determine monthly percentages of precipitation and runoff. Annual runoff was calculated from U. S. Geological Survey and Canadian Water Resources Branch surface water gaging data. Inflow and outflow were calculated from U. S. Lake Survey reported measurements. Changes in storage were calculated from average monthly water levels as reported by the U. S. Lake Survey. Evaporation was obtained by solving the equation for it.

The annual supply sources for the Lake Erie water balance are detailed in Table 3. The relative importance of each of the tributaries to the Lake Erie water supply is graphically shown in Figure 16.

In the water balance table, Table 4, cubic feet per second (cfs) has been used for the unit of volume. The values shown can be converted to inches of water in Lake Erie by dividing by 735.

A study of the water balance indicates the following significant factors: (1) annual evaporation nearly equals runoff to the lake, (2) evaporation exceeds precipitation, (3) change in storage over a long period is not significant, and (4) evaporation is greatest in late winter and in autumn.

Calculations show that 80 percent of the net basin supply is derived from Lake Huron inflow via the Detroit River, 9 percent is precipitation upon the lake's surface, and only 11 percent is contributed by basin runoff. Loss of water from Lake Erie consists of 86 percent outflow, 3 percent diversion, and 11 percent evaporation.

LAKE LEVELS

Lake levels vary over short periods of time due to such phenomena as wind set-up, seiches, and lunar and solar tides. But, lake levels show changes in storage only when averaged over long periods of time. Changes in storage for Lake Erie reflect precipitation fluctuations over it and the upper Great Lakes. From 1860 (the beginning of U. S. Lake Survey records) to the present, change between minimum and maximum levels for Lake Erie has been 5.3 feet - almost nine percent of the lake's average depth.

Short-period fluctuations mentioned above are manifested, not by changes in volume, but by changes in the shape of the water mass. Tidal effects are negligible, but wind set-up and seiches may be quite pronounced, especially at the ends of the lake.

A wind set-up is the result of wind drag across the lake. Water is pushed toward the leeward shore in greater quantity than can be simultaneously returned in subsurface flow. The water rises at the leeward side and is depressed at the windward side. Lake Erie is particularly susceptible to high amplitude wind set-ups because of its shallowness and the orientation of its long axis parallel to predominant southwest and northeast winds. Amplitudes in excess of 13 feet have been recorded simultaneously between the ends of the lake during storms, with little change in level near the center of the lake.

In general the highest amplitude wind set-ups occur in spring and fall with northeasterly and westerly winds, respectively. Flooding and erosion are severe when high amplitude wind set-ups occur, and are

TABLE 3

WATER SUPPLY TO LAKE ERIE

Source	Supply (cfs)	Percent of Total Lake Supply	Percent of Basin Supply
Western Basin			
St. Clair River (Lake Huron, outflow)	187,450	79,774	92.921
Black, Pine, Belle Rivers	688	.293	.338
Clinton River	470	.200	.231
Rouge River	235	.100	.115
Thames River	1,840	.783	.903
Miscellaneous Runoff	1,799	.766	.883
Precipitation (Lake St. Clair)	919	.391	.451
Subtotal (Detroit River)	193,401	82.307	94.943
Huron River (Michigan	556	.237	.273
Raisin River	714	.304	.351
Maumee River	4,794	2.040	2.353
Portage River	403	.172	.198
Miscellaneous Runoff	1,271	.541	.624
Precipitation (Western Basin)	2,564	1.091	1.259
Subtotal	10,302	4.384	5.057
Total Western Basin	203,703	86.691	100.000
Evaporation	-3,042	-1.295	-1.493
Central Basin			
Western Basin	200,661	85.396	90.966
Sandusky River	1,021	.435	.463
Huron River (Ohio)	296	.126	.134
Vermilion River	228	.097	.103
Black River	302	.129	.137
Rocky River	273	.116	.124
Cuyahoga River	850	.362	.385
Chagrin River	333	.142	.151
Grand River (Ohio)	784	.334	.355
Ashtabula River	169	.072	.077
Conneaut Creek	257	.109	.117
Otter Creek	312	.133	.141
Kettle Creek	185	.079	.084
Miscellaneous Runoff	1,410	.600	.639
Precipitation (Central Basin)	13,508	5.749	6.124
Total Central Basin	220,589	93.877	100.000
Evaporation	-16,023	-6.819	-7.264

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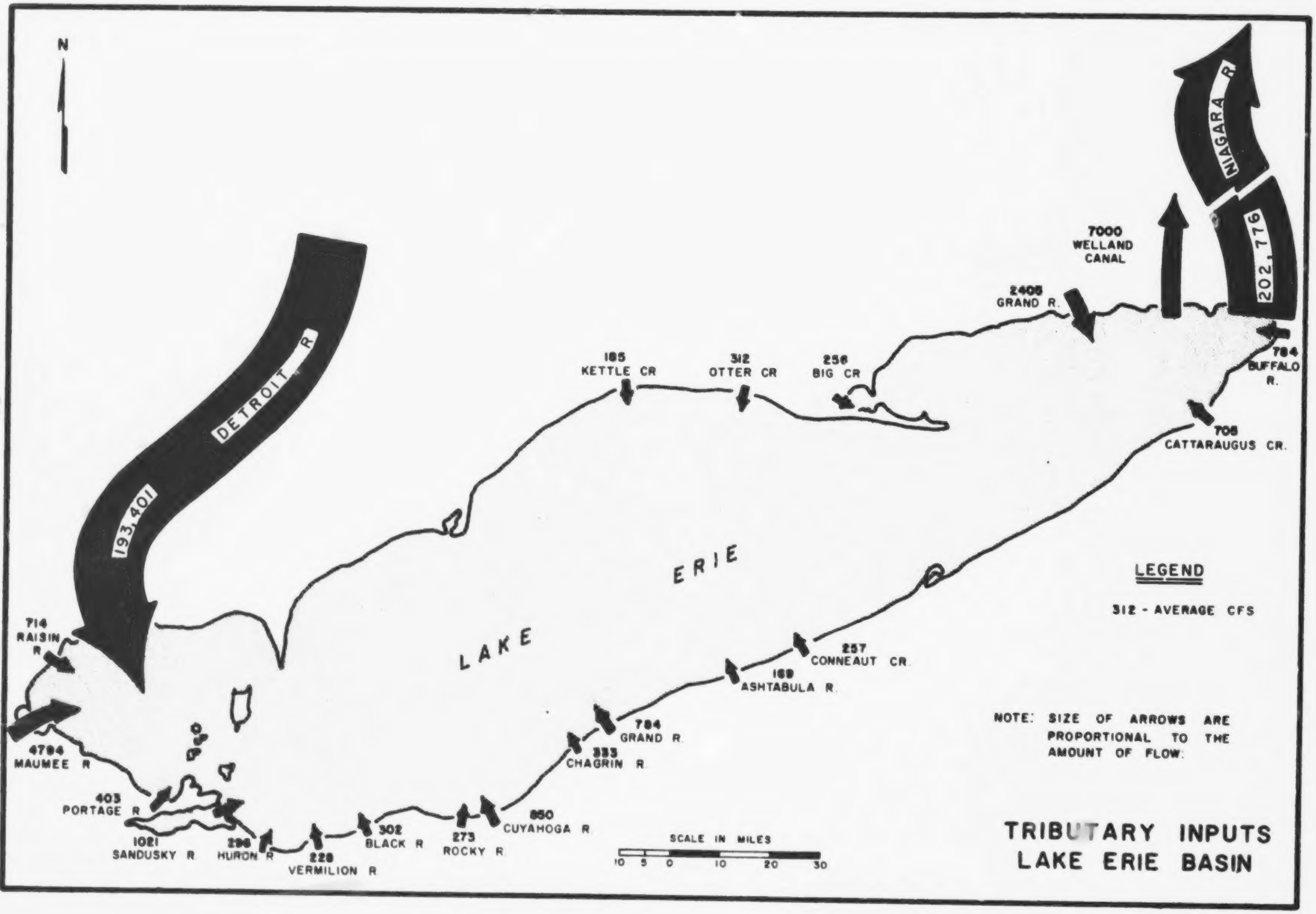
WATER SUPPLY TO LAKE ERIE (Concluded)

Source	Supply (cfs)	Percent of Total Lake Supply	Percent of Basin Supply
Eastern Basin			
Central Basin	204,566	87.058	94.746
Cattaraugus Creek	705	.300	.327
Buffalo River	784	.334	.363
Grand River (Ontario)	2,405	1.024	1.114
Big Creek	256	.108	.119
Miscellaneous Runoff	2,023	.861	.937
Precipitation (Eastern basin)	5,172	2.201	2.395
Total Eastern Basin	215,911	91.886	100.000
Evaporation	-6,135	-2.611	-2.841
Lake Outflow	209,776	89.275	

TABLE 4

WATER BALANCE IN LAKE ERIE
(cfs)

	P +	R +	I -	O -	D -	E =	ΔS
Annual Average	22,000	25,~~000~~ 500	187,000	203,000	7,000	25,000	0


N
193,401
DETROIT R
714
RAISIN R
4794
MAUMEE R
403
PORTAGE R
1021
SANDUSKY R
296
HURON R
228
VERMILION R
302
BLACK R
273
ROCKY R
850
CUYAHOGA R
333
CHAGRIN R
784
GRAND R
169
ASHTABULA R
257
CONNEAUT CR
706
CATTARAUGUS CR
784
BUFFALO R
185
KETTLE CR
312
OTTER CR
256
BIG CR
2405
GRAND R
7000
WELLAND CANAL
202,776
NIAGARA R
LAKE ERIE
SCALE IN MILES
10 5 0 10 20 30

LEGEND

312 - AVERAGE CFS

NOTE: SIZE OF ARROWS ARE PROPORTIONAL TO THE AMOUNT OF FLOW:

TRIBUTARY INPUTS
LAKE ERIE BASIN

FIGURE 16

330<

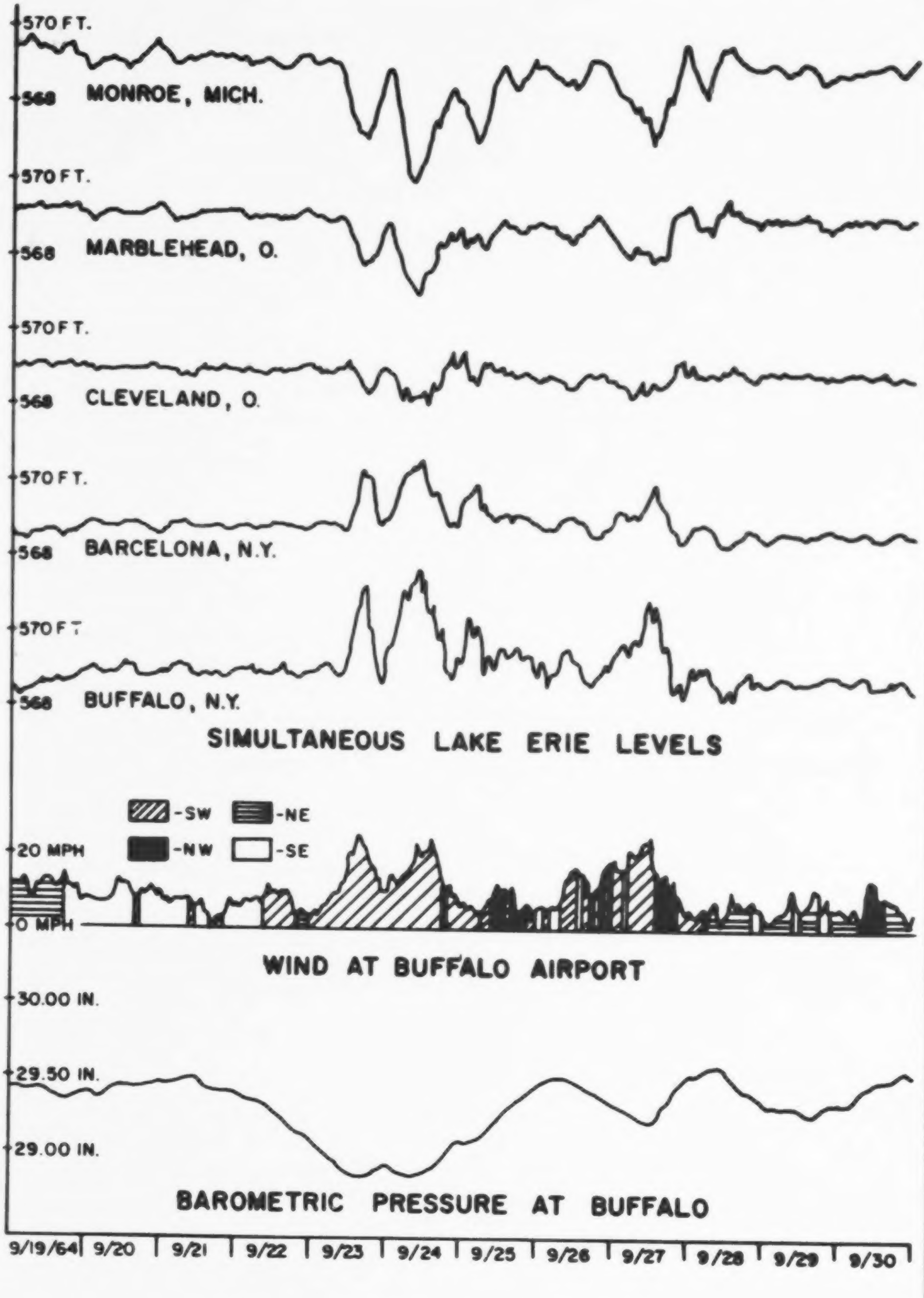
even more severe during periods of high lake levels (times of increased storage), especially in the western basin where the shores are low.

A wind set-up, which generally lasts less than 24 hours, forms a standing wave which will persist when the wind subsides. The standing wave, called a seiche, will persist and gradually diminish until another wind set-up. A typical example of wind set-ups and following seiches are shown in Figure 17 for simultaneous lake level readings at five different stations. Influencing winds and barometric pressure are also shown.

The primary seiche period of Lake Erie is 14.2 hours, that of the uninodal oscillation between the ends of the lake. This seiche period is nearly always apparent on water level records from west of Cleveland and east of Ashtabula, Ohio. Any number of seiches can exist together and each can have several nodes, giving rise to seemingly unintelligible water level records. Even the harbors, where most recorders are located, can have short-period seiches called surges or harbor resonance.

The shortest period oscillations of water level are simple surface waves caused by wind. In Lake Erie these waves ordinarily have periods of less than six seconds. Wave heights are limited by lake depths and fetch or length of water surface over which the wind blows. In general, maximum possible wave heights increase from west to east in Lake Erie. Waves over six feet in height are rare in the western basin, while similar conditions may produce wave heights of 15 to 20 feet in the eastern basin. Violence of waves in Lake Erie is caused by short wave lengths and the resulting wave steepness.

Waves are destructive to shore property in Lake Erie. The shoreline of Ohio is particularly susceptible because beaches are narrow and most banks are clay. Waves, of course, are more destructive during high lake stages and in areas of simultaneous wind set-up. In the western basin, wave action is believed to be the principal agent in maintaining the relatively high turbidity of the shallow water by stirring up bottom sediments. Table 5 lists some of the effects and causes of various kinds of water level disturbances.



LAKE LEVELS AND WINDS

SEPTEMBER, 1964

FIGURE 17

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TABLE 5

CAUSES AND EFFECTS OF WATER LEVEL CHANGES

Water Level Disturbance	Cause	Effects: Navigation	Effects: Shore Property	Effects: Pollution
Stage	Precipitation Inflow	High - good Low - adverse	High - adverse Low - good	None
Wind Set-up	Wind	Same as above	Same as above	Lee - concentration Windward - dispersal
Seiche	Wind Set-up	Same as stage	Same as above	Dispersal
Tide	Moon - Sun	None	None	None
Waves	Wind	High - adverse Low - none	Adverse	Dispersion and longshore transport

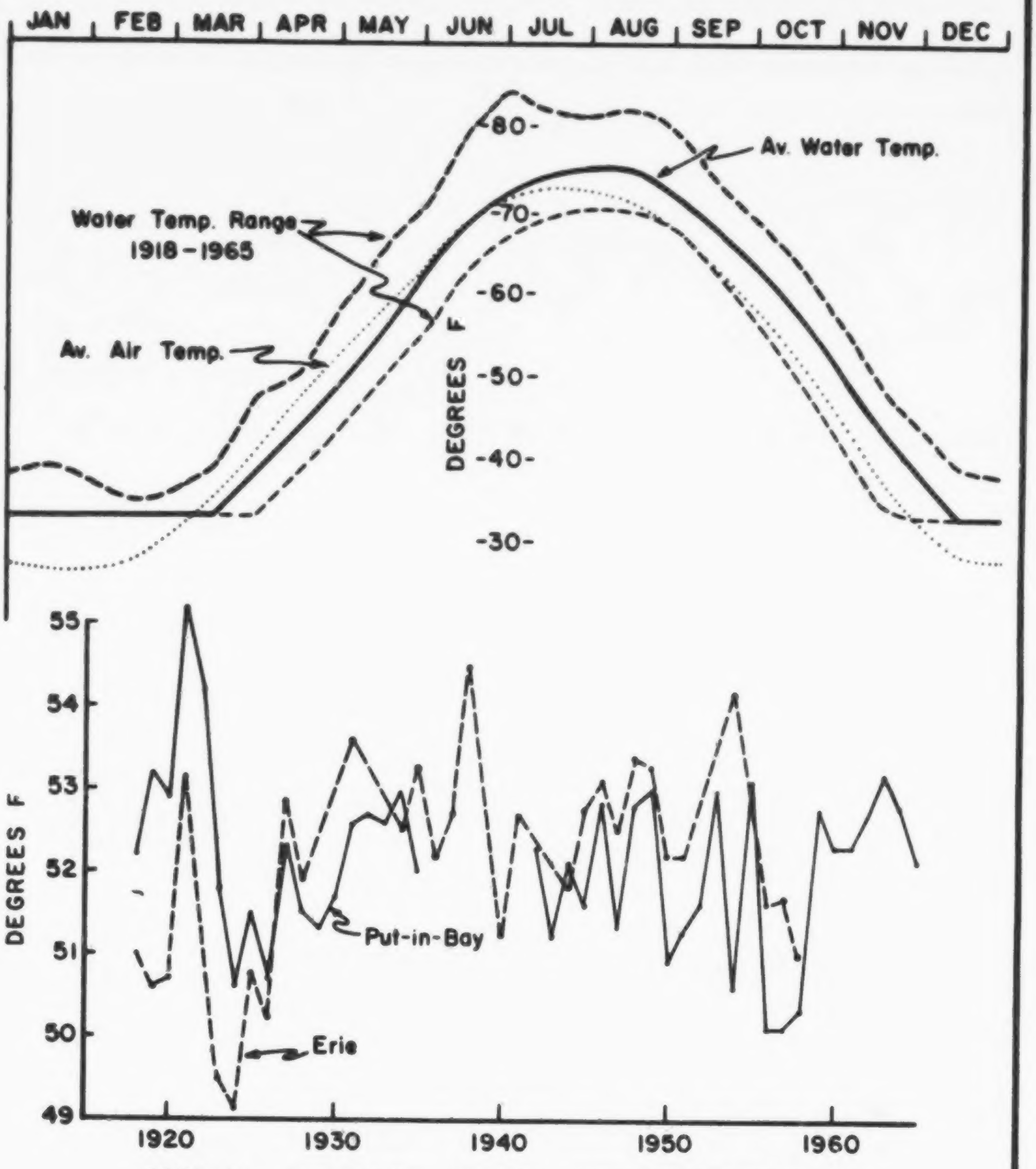
LAKE WATER TEMPERATURES

Lake Erie is the warmest of the Great Lakes. Mid-lake surface water reaches an average maximum of about 75°F (24°C) usually in the first half of August (Figure 18). Occasionally the summer temperature in mid-lake surface water rises above 80°F. Nearshore water normally reaches a maximum along the south shore of 80°F or more.

The most important characteristic of lake temperatures in summer is temperature stratification. If the water is deep enough upper warm water (epilimnion) becomes separated from bottom cold water (hypolimnion), Figure 19. The transition zone between these layers is called the thermocline.

Surface water temperatures throughout much of the ice-free seasons reflect water depth with temperature decreasing toward deep water (Rodgers, 1965). This inverse relationship changes to a direct relationship in the fall and early winter.

Water temperature is, of course, changed by variations in air

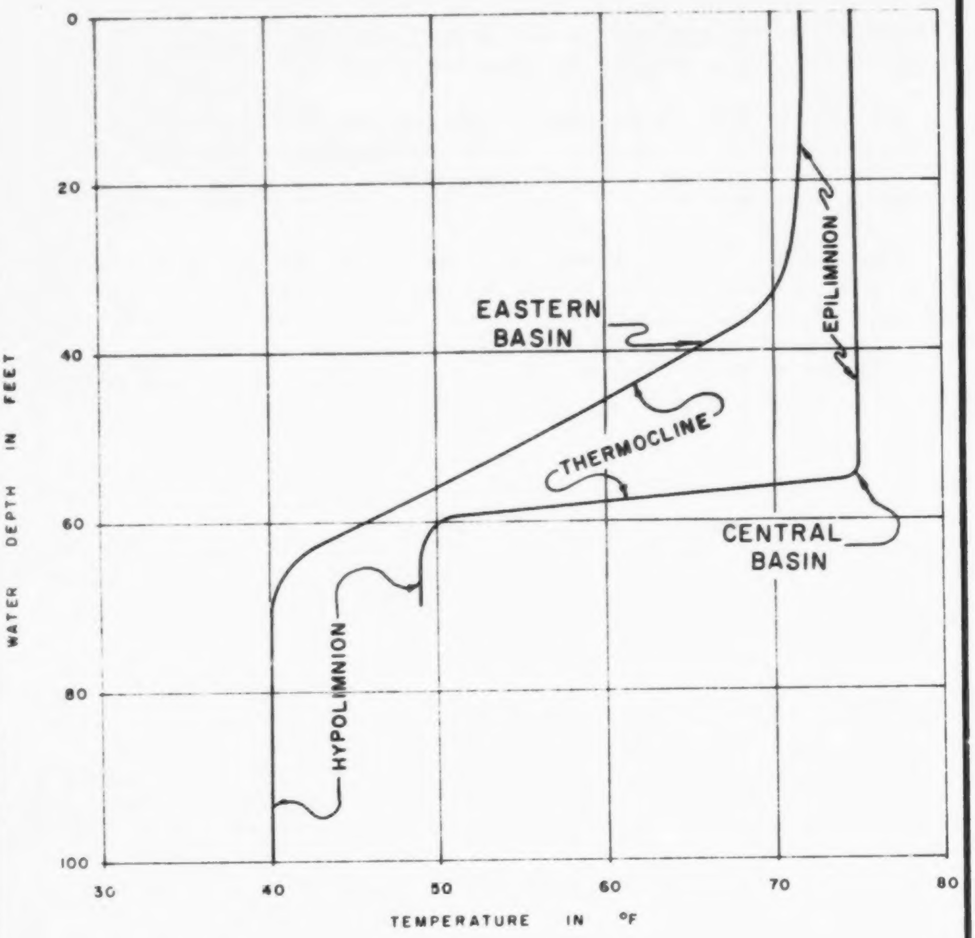


YEARLY WATER TEMPERATURE CURVE, PUT-IN-BAY, OHIO AND AIR TEMPERATURE AT TOLEDO, OHIO

ANNUAL AVERAGE WATER TEMPERATURES AT PUT-IN-BAY, OHIO AND ERIE, PENNSYLVANIA 1918-1965
(FROM OHIO DIV. OF WILDLIFE AND U.S. BUR. COMM. FISH. DATA)

334<

FIGURE 18



TYPICAL SUMMER DEPTH
VS.
TEMPERATURE IN LAKE ERIE

FIGURE 19

temperature, and the relationship is direct. Slight modifications to the relationship are caused by the amount of sunshine, strength and duration of winds, and by humidity.

Lake Erie water temperature, in the western basin, falls to 33°F normally about the middle of December and remains at that level until the middle of March. Usually the western basin freezes over completely. The surface water in the remainder of Lake Erie is at 33°F for about the same length of time, but normally about two weeks later, or from the first of January until the first of April. The central and eastern basins usually do not freeze over completely, but often are almost entirely covered by floe ice.

Just after the ice breakup in spring, the ice drifts eastward and accumulates in the eastern basin. Occasionally ice jams significantly impede the flow of the Niagara River. Ice normally disappears in Lake Erie by May 1.

Windrows of ice are common near the shore and on reefs. Wind exerts a significant force on the ice and can cause breakup without thawing conditions. Occasionally with onshore winds along the south shore of the western basin, ice piles up on shore, scouring the bottom as it moves in. At times it piles to heights of 30 feet or more and destroys buildings and other structures along the shore.

Spring ice breakup in the western basin, after it begins, occurs rapidly, going from complete ice cover to open water in a few days.

Warming of the lake water usually begins immediately after the ice breakup. The rate of warming is remarkably uniform until about the first of July when the maximum temperature is being approached and the rate flattens out.

A comparison of surface water temperature curves and air temperature curves (Figure 18) shows that during the ice-free season there is a definite and expected parallelism. The water temperature curve lags the air temperature by 9 to 12 days in spring and by 12 to 15 days in fall. The greatest departure is in midsummer when the air temperature decline begins about three weeks before the water temperature decline.

Figure 18 also shows temperature data from about 45 years of record maintained at the Ohio State Fish Hatchery at Put-in-Bay (Ohio Division of Wildlife, 1961). Mean monthly water temperatures are shown. Also annual average temperatures are shown for the period for Put-in-Bay and for the Erie, Pennsylvania water intake as compiled by the U. S. Bureau of Commercial Fisheries. The Erie record shows a trend toward higher temperatures during the period and the Put-in-Bay record shows a trend toward lower temperatures. Trends appear insignificant, however, especially since accuracy of measurement is at least questionable.

Temperature of the surface water of Lake Erie is of less significance than the three-dimensional temperature structure. This structure influences circulation of the water and its dissolved and suspended substances, and also has a marked influence on the chemical and biochemical activity at the bottom sediment-water interface.

WESTERN BASIN

Figures 20a, b, and c diagrammatically show the development of seasonal temperature structure in each of Lake Erie's three basins. Figure 20a for the western basin shows the simplest thermal structure. In spring the temperature of the entire water column rises gradually. In summer the water is usually nearly isothermal vertically. A transient secondary thermocline of little importance can be formed near the surface during hot calm periods. During periods of normal winds and above average air temperatures, a thermocline can be formed near the bottom, simultaneously with the development of a secondary thermocline in the central basin. This thermocline is accompanied by rapid deoxygenation of the bottom water due to oxygen-consuming material and the inability of oxygen to penetrate the thermocline.

Storms equalize temperatures in the western basin top to bottom. In August when cooling begins, the western basin water is vertically isothermal and remains so as it cools in fall and winter.

CENTRAL BASIN

The central basin water, Figure 20b, has a simple fall, winter, and spring thermal structure. In summer the structure is more complex than in the western basin. The temperature at the beginning of the first summer weather cycle in early June is approximately the temperature of the following hypolimnion.

The stable thermocline and hypolimnion are formed relatively suddenly during the first storm ending this weather cycle. The intensity of this storm determines the depth of the thermocline, and the thermocline remains at approximately its initial elevation until the lake begins to cool in August. The thermocline is normally tilted slightly upward to the north. During its existence the hypolimnion loses oxygen and may lose it all because it does not mix with the water above, and it contains oxidizable organic matter.

Summer weather cycles cause the epilimnion to alternate in structure between one layer and three layers. Storms equalize the temperature of the epilimnion. During the following warming period a secondary thermocline is formed by heat input and the mixing by normal winds to a depth of 6 or 7 meters. While this is forming the temperature of the epilimnion below this temporary thermocline is not changing. The temperature of this zone is then raised suddenly during the cycle-ending storm when the temperature of the entire epilimnion again becomes

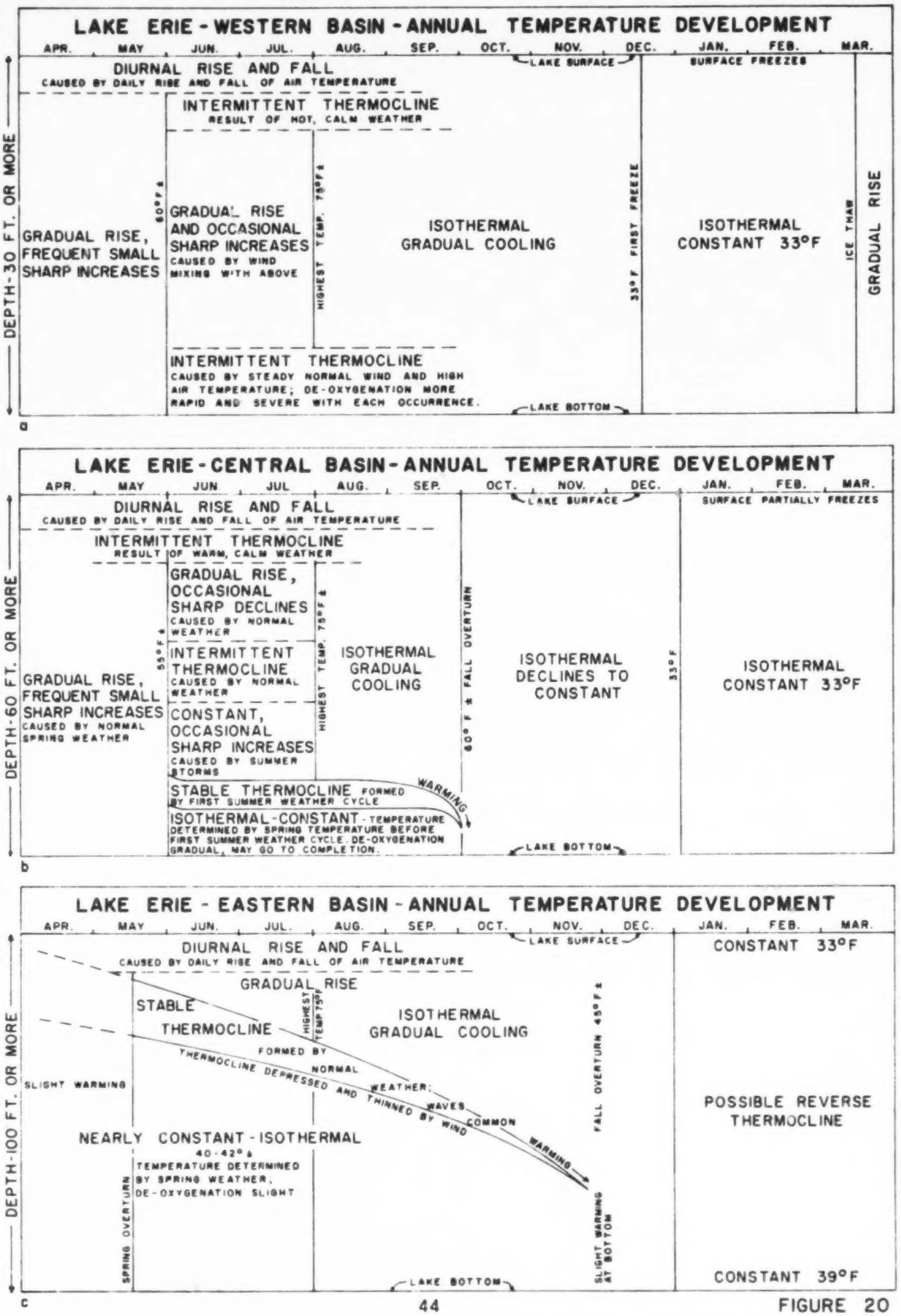

LAKE ERIE - WESTERN BASIN - ANNUAL TEMPERATURE DEVELOPMENT
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
LAKE SURFACE
DIURNAL RISE AND FALL
CAUSED BY DAILY RISE AND FALL OF AIR TEMPERATURE
SURFACE FREEZES
INTERMITTENT THERMOCLINE
RESULT OF HOT, CALM WEATHER
DEPTH-30 FT. OR MORE
60°F ±
GRADUAL RISE, FREQUENT SMALL SHARP INCREASES
GRADUAL RISE AND OCCASIONAL SHARP INCREASES
CAUSED BY WIND MIXING WITH ABOVE
HIGHEST TEMP. 75°F ±
ISOTHERMAL GRADUAL COOLING
33°F FIRST FREEZE
ISOTHERMAL CONSTANT 33°F
ICE THAW
GRADUAL RISE
INTERMITTENT THERMOCLINE
CAUSED BY STEADY NORMAL WIND AND HIGH AIR TEMPERATURE; DE-OXYGENATION MORE RAPID AND SEVERE WITH EACH OCCURRENCE.
LAKE BOTTOM
a
LAKE ERIE - CENTRAL BASIN - ANNUAL TEMPERATURE DEVELOPMENT
APR.
MAY
JUN
JUL
AUG.
SEP.
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
LAKE SURFACE
DIURNAL RISE AND FALL
CAUSED BY DAILY RISE AND FALL OF AIR TEMPERATURE
SURFACE PARTIALLY FREEZES
INTERMITTENT THERMOCLINE
RESULT OF WARM, CALM WEATHER
DEPTH-60 FT. OR MORE
GRADUAL RISE, OCCASIONAL SHARP DECLINES
CAUSED BY NORMAL WEATHER
55°F ±
INTERMITTENT THERMOCLINE
CAUSED BY NORMAL WEATHER
HIGHEST TEMP. 75°F ±
ISOTHERMAL GRADUAL COOLING
60°F ± FALL OVERTURN
ISOTHERMAL DECLINES TO CONSTANT
33°F
ISOTHERMAL CONSTANT 33°F
GRADUAL RISE, FREQUENT SMALL SHARP INCREASES
CAUSED BY NORMAL SPRING WEATHER
CONSTANT, OCCASIONAL SHARP INCREASES
CAUSED BY SUMMER STORMS
STABLE THERMOCLINE FORMED BY FIRST SUMMER WEATHER CYCLE
WARMING
ISOTHERMAL-CONSTANT - TEMPERATURE DETERMINED BY SPRING TEMPERATURE BEFORE FIRST SUMMER WEATHER CYCLE. DE-OXYGENATION GRADUAL, MAY GO TO COMPLETION.
LAKE BOTTOM
b
LAKE ERIE - EASTERN BASIN - ANNUAL TEMPERATURE DEVELOPMENT
APR.
MAY
JUN.
JUL.
AUG.
SEP.
OCT.
NOV.
DEC.
JAN.
FEB.
MAR.
LAKE SURFACE
DIURNAL RISE AND FALL
CAUSED BY DAILY RISE AND FALL OF AIR TEMPERATURE
CONSTANT 33°F
GRADUAL RISE
STABLE
THERMOCLINE
HIGHEST TEMP 75°F
ISOTHERMAL GRADUAL COOLING
FALL OVERTURN 45°F ±
FORMED BY NORMAL WEATHER; WAVES COMMON
THERMOCLINE DEPRESSED AND THINNED BY WIND
DEPTH-100 FT. OR MORE
SLIGHT WARMING
POSSIBLE REVERSE THERMOCLINE
WARMING
NEARLY CONSTANT - ISOTHERMAL
40-42° ±
TEMPERATURE DETERMINED BY SPRING WEATHER; DE-OXYGENATION SLIGHT
SPRING OVERTURN
SLIGHT WARMING AT BOTTOM
CONSTANT 39°F
LAKE BOTTOM
c

FIGURE 20

uniform. The density gradient at the stable thermocline is thus increased. The whole process is repeated several times before August. Figure 21 shows the summer cyclic development at station E-8 (Figure 23) in the central basin. In August the epilimnion begins to cool and loses its three-layer structure. The density gradient at the thermocline decreases and the thermocline deepens, disappearing entirely by October.

Upwelling, downwelling, and internal waves are created during summer storms in the central basin, especially during northwesters. The hypolimnion slides around in the basin. This water movement probably brings bottom sediments into suspension and this may increase oxygen consumption, bringing about relatively sudden oxygen depletion in the hypolimnion. Internal waves other than up and downwelling in the central basin probably have amplitudes of less than five feet, as indicated by a study in the summer of 1965. Periods range from less than five minutes to two weeks or more, with an inertial period near eighteen hours apparently predominant.

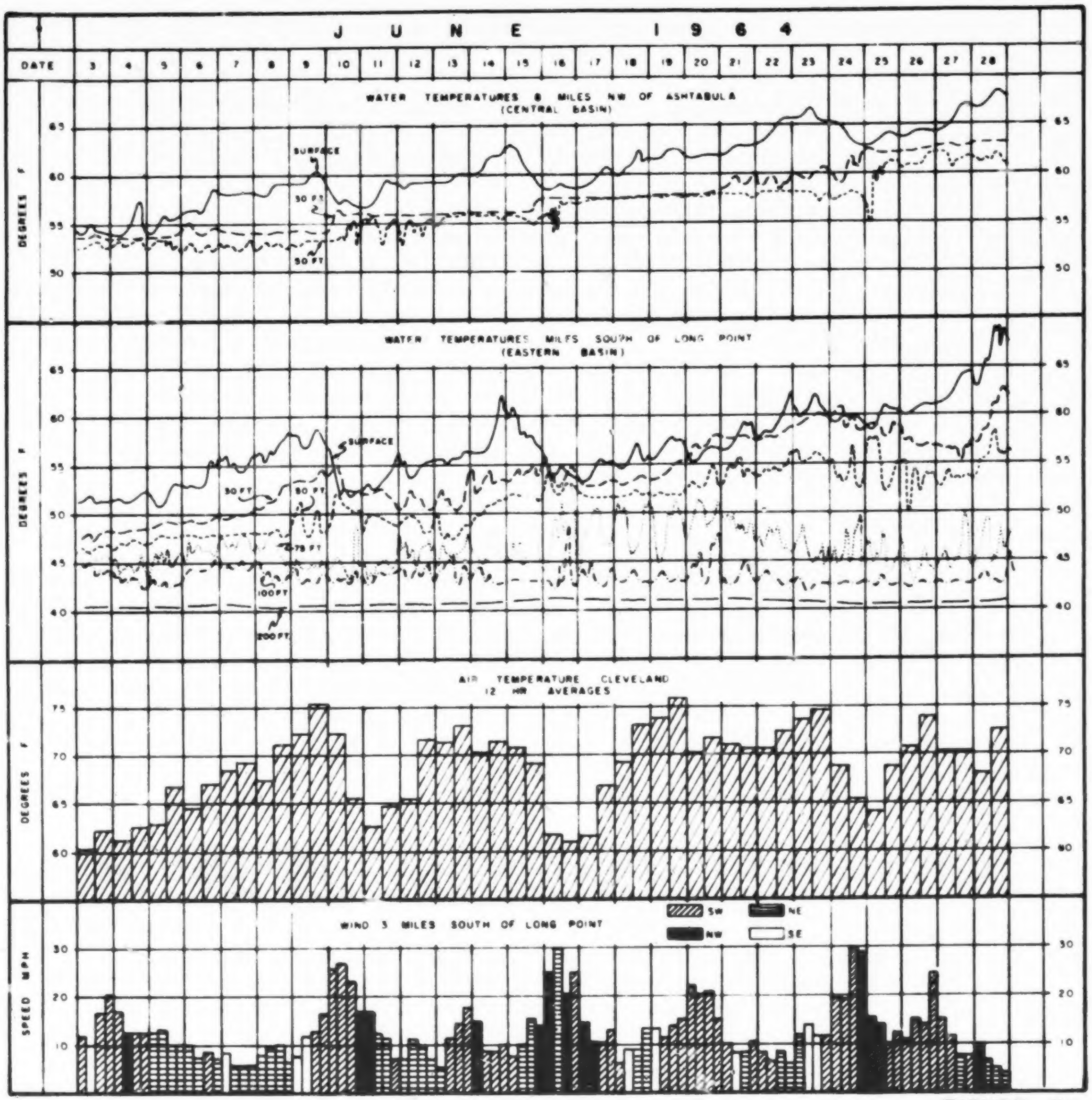
EASTERN BASIN

The temperature structure of the eastern basin is probably like that of the deeper Great Lakes, Figure 20c. In winter it is nearly isothermal and may have reverse stratification. In spring it mixes top to bottom and is vertically isothermal. The upper waters warm gradually and a shallow thick thermocline forms early, thinning and deepening as summer progresses. The epilimnion is mixed more often or more constantly than in the central basin. Figure 21 shows a typical summer thermal development at station E12 and E14 (Figure 23) in the eastern basin.

Mixing in the epilimnion of the eastern basin may be aided greatly or perpetuated by relatively high amplitude thermoclinal waves. Significant internal wave motion is virtually constant throughout the summer with an inertial 17 to 18-hour period dominant. The thermocline thins and deepens rapidly after the epilimnion begins to cool. Just before the thermocline disappears, usually in November, it has reached a depth of 100 feet or more. With its disappearance the hypolimnion zone warms somewhat, due to mixing, and then begins to cool to winter temperatures.

NEARSHORE WATER TEMPERATURES

Temperature plays an important role in nearshore waters. The significance is not great in winter because the temperature is nearly uniform throughout the lake. However, during the other three seasons waters of different temperatures are in contact and density interfaces are formed, inhibiting mixing processes and resulting in currents which would not otherwise exist.

J U N E 1 9 6 4
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25
26
27
28
WATER TEMPERATURES 8 MILES NW OF ASHTABULA
(CENTRAL BASIN)
DEGREES F
65
60
55
50
SURFACE
30 FT
50 FT
WATER TEMPERATURES MILES SOUTH OF LONG POINT
(EASTERN BASIN)
DEGREES F
65
60
55
50
45
40
SURFACE
30 FT
50 FT
75 FT
100 FT
200 FT
AIR TEMPERATURE CLEVELAND
12 HR AVERAGES
DEGREES F
75
70
65
60
WIND 3 MILES SOUTH OF LONG POINT
SPEED MPH
30
20
10
SW
NE
NW
SE

FIGURE 21

During the spring and summer, and strongly in the spring, a temperature differential may exist between nearshore and offshore waters. The water within a mile or so off shore is usually considerably warmer. The greatest differential appears to exist along the south shore of the central basin. The primary reasons for this are warm tributary discharges and the southwest winds over the lake pushing warm surface waters toward the right of the wind or toward the south shore. North shore nearshore waters do not appear to be greatly warmer than mid-lake water at any time of the year. The prevailing southwest winds here too may be largely responsible.

There is less lateral variation in the eastern basin in water temperatures, probably because of less tributary input and deeper nearshore water. The warmest water there is also normally along the south shore in spring and summer.

The nearshore temperature structure in spring and summer indicates an eastward movement of south shore nearshore water. The physics of the system require this movement. Current measurements at several nearshore stations have confirmed it.

In the western basin the disruptive influences of the Detroit River inflow, bottom topography and the islands do not allow the development of the same nearshore thermal structure. Figure 22 shows a typical temperature distribution in the western basin in early summer.

EFFECTS OF TEMPERATURE PHENOMENA

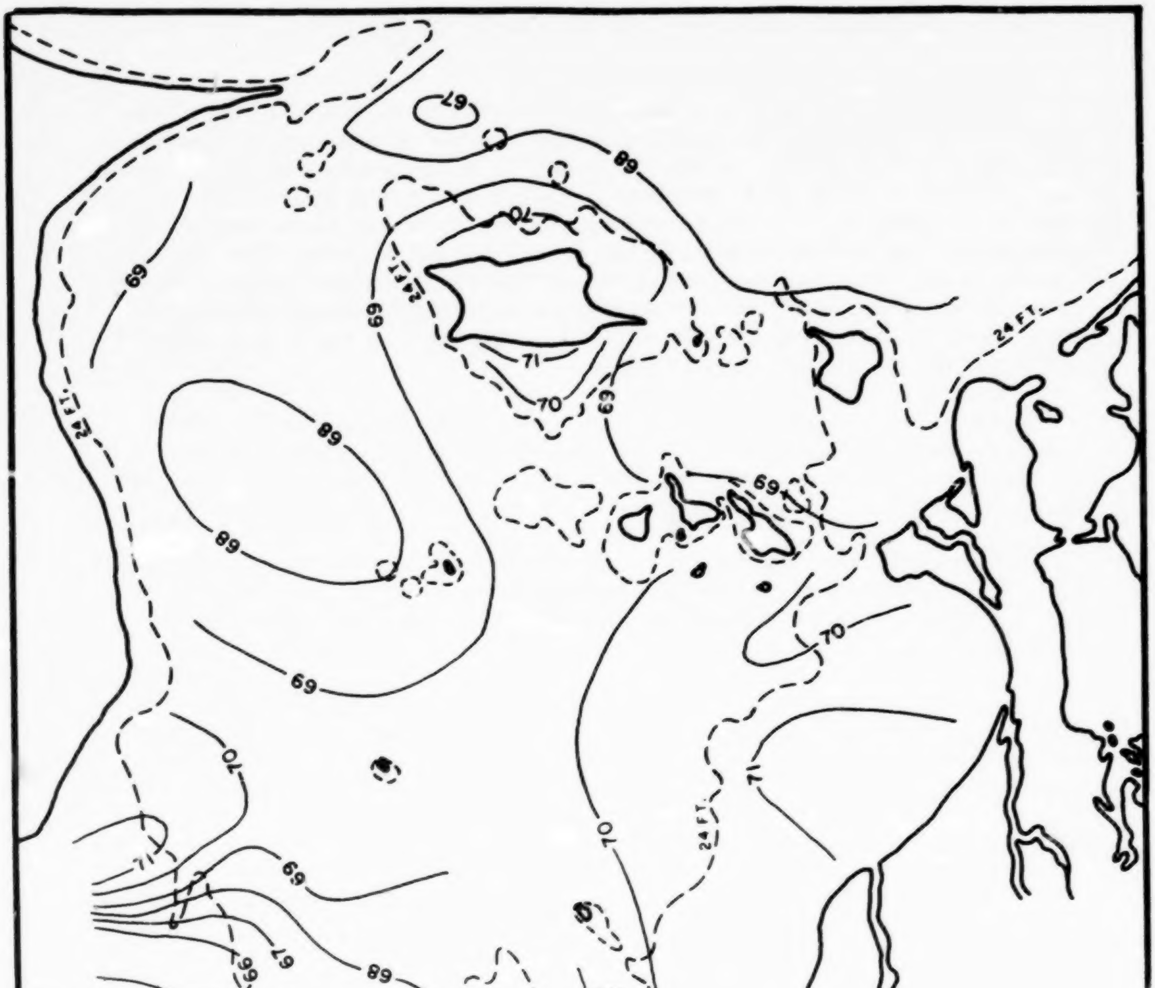
Temperature plays a most important role in Lake Erie processes as does the temperature-related density stratification. Some of the more important effects are:

1. Actual temperature controls plant and animal productivity of the lake to some degree; in general the higher the temperature, the greater the productivity.

2. Intermittent thermal stratification near the bottom of the western basin leads to rapid deoxygenation of the water in the hypolimnion, when and where it occurs. The warmer the hypolimnion the more rapid the deoxygenation will be.

3. Stable summer thermal stratification in the central basin leads to the annual deoxygenation of hypolimnetic water.

4. Thermal stratification in the eastern basin does not have serious consequences because of the much greater thickness and less rapid circulation of the hypolimnion.


67
68
69
70
71
24 FT.
N
SCALE
5
0
5
10

TEMPERATURE DISTRIBUTION
IN
LAKE ERIE - WESTERN BASIN
10-FT. DEPTH 6/23/63

CONTOUR INTERVAL
1°F.

FIGURE 22

342<

5. Temperature is important in controlling water movements in nearshore areas. Density barriers may confine warmer waters and pollution substances to the nearshore zones, especially along the south shore, in spring and summer.

6. Temperature rises in general limit top to bottom mixing; temperature declines favor it.

LAKE CURRENTS

Two basic types of circulation exist in Lake Erie: (1) Horizontal motion and (2) essentially vertical motion. Each of these can be genetically subdivided as follows:

Horizontal Currents

(1) Lake flow-through
(2) Wind-driven
(3) Seiche
(4) Inertial
(5) Density
(6) Turbulence

Vertical Currents

(1) Temperature gradient (convection)
(2) Turbidity gradient
(3) Dissolved solids, gradient
(4) Convergence of horizontal currents
(5) Divergence of horizontal currents
(6) Turbulence

Generally more energy is involved in horizontal than in vertical currents. All currents tend to relocate and disperse suspended or dissolved constituents. The movement may be quite different between offshore and nearshore waters because of the effects of bottom topography and boundary conditions.

The lake flow-through current is always a net movement eastward. This, however, does not mean that, at all places at all times, a flow-through component is included. It is possible that this component of water movement is found only on one side of the lake or that it wanders from one side to the other. Throughout the water column, it should be essentially uni-directional, with no compensating return flow. All other types of currents are superimposed and, except in restricted channels, the flow-through may be completely masked.

The flow-through current of Lake Erie can be considered as the most significant agent in distribution of dissolved substances because most of these substances are introduced near or at the source of the flow-through. Because of its generally very low velocity, it is not significant in the transport of suspended material. The exceptions are in restricted channels.

Wind-driven currents are, as the term implies, the movements of water directly caused by wind stress at the water surface. These currents are the fastest and the most variable in direction of the large-scale water movements. Large volumes of water can be moved in a very short time, as in wind set-up.

The first effect of wind is to produce waves. Waves, in themselves, are not significant transporters of water, at least in deeper areas of the lake. Most of the motion is orbital in a vertical plane decreasing downward from the surface to zero at a depth equal to the wave length. There is only a slight net transport of water in the direction of wave progress. However, when waves reach shallow ater (half the wave length or less) they change from orbital to a to and fro motion. The slight net transport still exists and along with the effects of gravity on the return flow and wind drag, littoral or longshore currents are created. Such currents can be especially rapid when the wave approach is toward shore at some angle other than normal.

Waves in mid-lake (also along shore) can produce turbulence and if the water is shallow enough, bottom sediments may be thereby brought into suspension. In deep water this is not a significant agent, in itself, for transport of sediment. It may be looked upon as an agent for mixing essentially in situ. However, wave turbulence may bring sediment up into the water to be transported by other currents.

The second effect of wind is to drag, en masse, a volume of water more or less in the direction of the wind. This is probably the major factor in wind set-up. The drag decreases with depth and so does the imposed velocity. If the volume of water moved cannot escape from the lake, two things will happen: (1) the water level will rise at the leeward end of the lake and (2) a subsurface return flow will be created. If there is adequate depth so that there is an unrestricted return flow, the rise in level will be small. In Lake Erie the water is shallow, the return flow is restricted, and the disturbance of water level is pronounced.

The above description of wind-driven currents is greatly oversimplified. The currents are influenced by the Coriolis effect, by previously established wind-driven currants, by water temperature, by air temperature, by the local and overall shape of the basin, by the force of the wind, by the distance of wind travel over water (fetch), and by the direction and duration of the wind.

Seiche currents are those created in the standing wave motions of seiches. Seiches, of course, depend upon the wind (rarely atmospheric pressure change along) for their creation. After the wind set-up, a seiche and its currents are self-sustaining. They degenerate by friction. Degeneration is seldom, if ever, complete because seiches are normally rejuvenated and/or changed by the wind.

The highest velocity seiche currents in a symmetrical basin occur along and normal to the nodal line of a particular seiche, and the velocity decreases to a minimum at the locations of maximum amplitude. Superimposed and multinodal seiches can lead to complex and seemingly unintelligible motions. In Lake Erie the longitudinal seiche dominates and the motions associated with it over-ride the others. Currents reach significant velocities in the nodal zone (roughly across the lake from Fairport, Ohio) and in the inter-island channels.

Seiche currents apparently do not result in a net transport of water; the motion is to and fro and balancing.

Density currents are those resulting when water of a different density is brought into the lake. Density differences can result from temperature differences, differences in dissolved solids content, differences in suspended solids content, or any combination of these.

Density currents are the most apparent and probably have their greatest importance in boundary waters. They provide a mechanism for a more rapid horizontal distribution of tributary inputs than would otherwise occur. When tributaries are warmer than the lake, the inputs can override the lake water, and vice versa. In either case the inputs can spread widely offshore. Density currents from differences in dissolved solids or suspended solids content nearly always tend to force input water to under-run lake water. If however, the solids-laden water is of high enough temperature, it can override the lake water, and this often happens in Lake Erie. Paradoxically, density differences in a vertical plane can often be sustained, especially with water temperatures near 4°C (39°F), the temperature of maximum density, preventing lateral dispersion and confining inputs to the nearshore zone.

Density currents are not compensating. Their movement is ordinarily offshore with no return of the same water.

Turbulence, to some degree, is associated with all other types of currents. This is more or less random motion, with horizontal and vertical components. Its main effect might be considered as that of mixing or dispersion, in that a given volume of water will, after a given time, be found throughout a much larger volume. Turbulent motion is most pronounced when associated with wind-driven currents.

Convection is vertical circulation caused by heat transfer. It is important in Lake Erie during the cooling period from August to January. The surface water loses heat to the atmosphere, becomes colder than lower water, and sinks. Warmer water rises to replace it. This process continues until the water column reaches 4°C, the temperature of maximum density. This kind of circulation probably cannot be called currents in the strictest sense, but it is highly effective in exchanging water between the surface and bottom. Heat loss from the water is the only factor needed to sustain this kind of motion.

Convection currents are of little consequence during the warming months, with the possible exception of short periods of colder air temperatures during storms. The over-running of cold water from tributaries can cause convection currents, but this is not common.

Turbidity and dissolved solids gradients can cause vertical circulation if, like over-running of cold water, they can be formed with the denser water on top. This situation is not normal.

Convergence of horizontal currents can cause vertical movement if at some lower or higher level there are diverging currents. Converging surface currents lead to downward movement. Diverging surface currents lead to upward movement.

Turbulence, associated with storm activity, is the most effective vertical motion at all seasons of the year. The result is rapid, vertical mixing in unstratified water from top to bottom, and above the density barrier if the water is stratified.

Currents in Lake Erie have been studied from time to time since before the turn of the century. Most studies have been largely confined to the western basin of the lake.

Only one attempt has been made in the past to show the general water circulation pattern for the entire lake. This was by Harrington (1895).

Circulation in the western basin has been investigated by several workers, including Harrington (1895), Wright (1955), Olson (1950), Verber (1953, 1954), and recently by the U. S. Bureau of Commercial Fisheries. The eastern basin has been neglected except for a rather local study in the Long Point area by Green (Fish, 1960).

The Federal Water Pollution Control Administration measured currents continuously and synoptically at selected locations in the western, central, and eastern basins. The U. S. Lake Survey has also similarly measured currents near a few selected harbors on Lake Erie. These programs are the first of their kind in Lake Erie.

Nearly all past work has relied upon data gathered from the release of drift cards, drift bottles, and shallow drogues. Only a very small amount of metering has been done, and this was by manual methods. Some attempts have been made to map chemically or physically different water masses, thereby inferring water circulation, in the western basin.

Harrington (1895), using drift bottles, deduced the surface currents of Lake Erie. In the western basin he showed the Detroit River fanning out from the Michigan shore to the Canadian shore. The eastern half of the Detroit River flow went directly to Pelee Passage. The remainder apparently flowed south and eastward to discharge through the South Passage with a small amount going northward to Pelee Passage. He also showed a clockwise movement around Pelee island and a counterclockwise movement around Kelleys Island.

Olson (1950) made a study of surface currents in western Lake Erie in 1948 and 1949 using drift cards. He divided the Detroit River flow into three parts, which he called the "Colchester Convergence", the "Pigeon Bay Drift", and the "Pelee Passage Drift" (See Figure 1). This implies that the Detroit River flow stays along the north shore, passing into the central basin via Pelee Passage. He showed a drift toward shore along the Michigan shore and indeterminate flow along the south shore. He stated that Maumee River water must flow through South Passage or between the islands, but indicated a to and fro motion in those channels. He also showed a clockwise movement around Pelee island which he called the "Pelee Island Gyre".

Wright (1955) studied the surface currents of western Lake Erie in 1928 using drift bottles. He drew no conclusions except to state that surface currents were not constant but were highly dependent upon the wind. Most of his bottles released near the Ohio and Michigan mainland shores went southward while most bottles released just west of the islands went northward.

Verber (1953, 1954), using drift cards, drogues, and a current meter in the inter-island channels, concluded that a rotational movement of water existed in western Lake Erie. Measurements in Pelee Passage, at depth as well as at the surface, indicated a larger outflow from the western basin than inflow in that channel and vice versa in the southern channels. He also concluded that most of the Detroit River water moved eastward through Pelee Passage.

The U. S. Bureau of Commercial Fisheries in recent work, using drogued drift bottles for measurement, indicated that surface currents in western Lake Erie are dependent upon winds. Southerly winds push the surface water toward the north shore and Pelee Passage. Westerly and northwesterly winds result in a flow pattern more or less similar to that of Harrington with Detroit River water reaching deep into the basin. Northeast winds push water toward the west shore with a simultaneous flow out of the Pelee Passage.

The Detroit Project, FWPCA, investigated currents near the mouth of the Detroit River and along the Michigan shore with dye and drogues. They deduced that outside the influence of river flow that currents were controlled by and essentially followed the wind direction.

The Ohio Department of Natural Resources (Hartley, Herdendorf, and Keller, 1966) measured conductivity and temperature in a dense pattern in the western basin on 23 June 1963. They indicated that the main part of the Detroit River flow extended far southward into the basin at the surface and at depth. The west part of the river followed the Michigan and Ohio shores moving northward west of the islands. The east part of the Detroit flow appeared to be moving east along the Canadian shore. The bulk of the western basin water was moving out through the Pelee Passage.

The only published work attempting to describe the circulation of central Lake Erie is that of Harrington (1895). He showed a general down-lake surface flow with a counter-clockwise gyre between Point Pelee and Pointe Aux Pins, Ontario, and East of Pointe Aux Pins. He also showed the gyre around Pelee island extending several miles into central Lake Erie.

Green (Fish, 1960) measured currents at a few isolated sites in central Lake Erie in 1929 without showing significant movements.

The U. S. Bureau of Commercial Fisheries recent work with shallow drogues indicates eastward flow in nearly all cases in mid-lake. They indicate that the Pelee Passage discharge reaches the Ohio shore between Sandusky and Lorain.

The Ohio Department of Natural Resources, with some direct measurements in the southeastern part of the basin indicates that complex patterns of water movement may exist both areally and in depth. Also their work indicates that eddies are common around harbor breakwaters which are not shore-connected. This has been confirmed by the U. S. Lake Survey in their harbor work.

Even less is known of eastern basin water circulation. The only known past attempt to measure currents in the eastern basin was by Green in 1929 as reported by Fish (1960). Green used a current pole and a Price current meter to measure velocities in the deeper water of the basin. He admitted that his measurements at depth were probably too high in value. In general he found, on the few occasions of measurement, that there was a rather rapid flow eastward, especially near Long Point. He also found that surface flow opposed the wind quite often. Flow patterns, other than eastward dominant movement cannot be shown from his data.

Drift bottles, drift cards and shallow drogues, released by the U. S. Bureau of Commercial Fisheries and the Ohio Department of Natural Resources in the western and central basins in recent years, have arrived on Long Point and the south shore of the eastern basin in great numbers. Only a few drifted to the north shore of the eastern basin east of Long Point. This probably indicates an eastward cross-lake flow of surface water.

In order to further describe the prevailing circulation patterns, the U. S. Public Health Service (now the Federal Water Pollution Control

Administration), in May 1964, established a system of automatic current metering stations in Lake Erie. The metering program was maintained until September 1965. The station locations and kinds of measurements are shown on Figure 23. Table 6 lists the stations, the depths at each meter, and the time of station occupancy. Temperature recorders were installed in conjunction with the current meters. Wind recorders were installed on most stations, but only during summer.

The metering program could not describe currents very near the lake bottom. Therefore, in the summer of 1965 seabed drifters were released at selected locations in Lake Erie (Figure 24). These small drifters contained instructions to return to the sender.

Intensive, localized, short-term drogue studies were made near the mouth of the Detroit River and off western Cleveland in the summer of 1964. These were made to learn something of lake dispersion and local currents.

Dye studies of short duration were carried out near the mouths of several tributaries along the south shore of the central basin during the summer of 1965, using Rhodamine B dye.

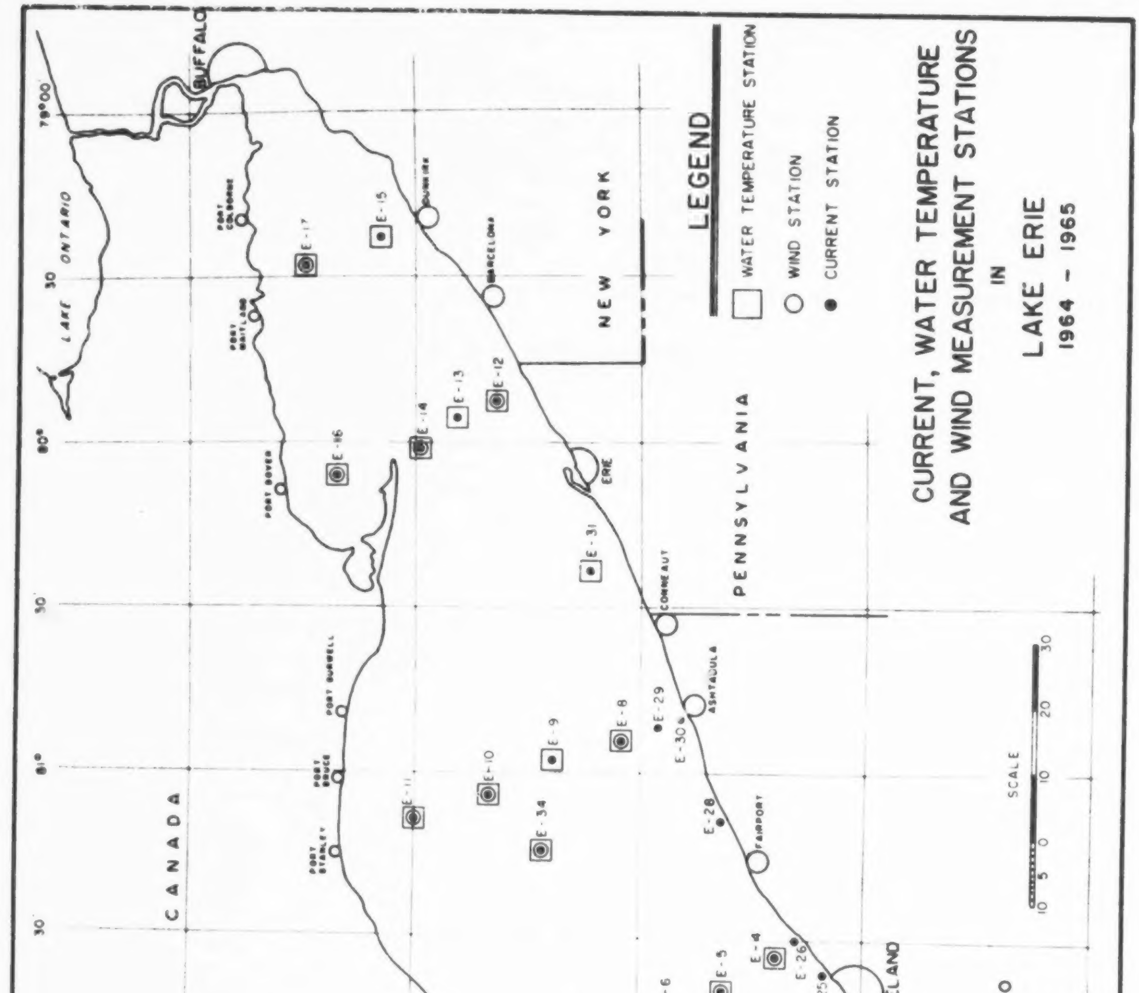
The metering program and seabed drifters have shown movement patterns very unlike the surface water movements which must exist in Lake Erie.

It is very difficult to describe predominant flows three-dimensionally when directions vary with depth and location, and such is the case in Lake Erie. Therefore the following description will deal mainly with surface and bottom currents, and much of the interpolation between top and bottom will be left to the reader.

WESTERN BASIN CIRCULATION

As noted previously, the water movements of the western basin have been studied more than in any other area of Lake Erie. Combining the facts determined in all those studies, a pattern of most probable dominant summer surface currents has been compiled as shown in Figure 25. The surface currents in the western half ot the western basin are dominated by the Detroit River inflow. However, in the eastern half of the basin the surface flow becomes more influenced by the prevailing southwesterly winds, and this effect produces a clockwise flow around the islands. Eddy effects along the sides of the Detroit River inflow lead to sluggish movement of surface water west of Colchester, Ontario and between Stony Point, Michigan and Toledo. These eddies tend to retain waters contained within them, leading to higher concentrations of pollutants commonly found in these areas.

The surface flow of the western basin water is often changed by


LEGEND
WATER TEMPERATURE STATION
WIND STATION
CURRENT STATION
CURRENT, WATER TEMPERATURE AND WIND MEASUREMENT STATIONS IN LAKE ERIE 1964 - 1965
SCALE
10 5 0 10 20 30
LAKE ONTARIO
LAKE HURON
LAKE ST. CLAIR
CANADA
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
BUFFALO
DUNKIRK
BARCELONA
ERIE
CONNEAUT
ASHTABULA
FAIRPORT
CLEVELAND
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
TOLEDO
MONROE
DETROIT
KINGSVILLE
LEAMINGTON
WHEATLEY
PORT CREWE
ERIEAU
PORT STANLEY
PORT BRUCE
PORT BURWELL
PORT DOVER
PORT MAITLAND
PORT COLBORNE
E-1
E-2
E-3
E-4
E-5
E-6
E-7
E-8
E-9
E-10
E-11
E-12
E-13
E-14
E-15
E-16
E-17
E-18
E-19
E-20
E-22
E-23
E-24
E-25
E-26
E-28
E-29
E-30
E-31
E-33
E-34
79°00'
30'
80°
30'
81°
30'
82°
30'
83°
83°30'
43°00'
30'
42°
30'
41°
N

350<

TABLE 6

CURRENT METERING STATION DESCRIPTION DATA
(station locations on Fig. 4-7)

Station Number	Meter depth (ft.)	Time of station occupancy*
E-1	30	5/18-10/12/64, 11/26/64-9/17/65
E-2	30	5/19-10/13/64, 11/26-4/20/65
E-3	30	5/19-8/6/64, 11/26/64-9/16/65
E-4	30, 50	5/19-10/11/64, 10/14/64-9/18/65
E-5	30, 50	5/19/64-5/1/65
E-6	30, 50	5/19/64-4/28/65
E-7	30, 50	5/19/64-9/17/65
E-8	30, 50	5/20-10/15/64, 5/3-9/19/65
E-9	30, 50	5/20-10/15/64, 10/16/64-5/2/65
E-10	30, 50	5/20/64-8/5/65
E-11	30, 50	5/20/64-9/17/65
E-12	30, 50, 75, 100	5/20/64-9/20/65
E-13	30, 50, 75, 100	5/20-10/15/64
E-14	30, 50, 75, 100, 185	5/20-9/20/65
E-15	30, 50, 75	5/21-10/23/64, 5/7-9/23/65
E-16	30, 50, 75	5/20-10/18/64
E-17	30, 50	5/7-9/24/65
E-18	30	6/11-8/6/64, 4/21-9/16/65
E-19	30	4/21-9/16/65
E-20	15	6/12-7/17/65, 8/11-9/17/65
E-22	15	6/12-7/17/65
E-23	15	6/12-7/17/65
E-24	15, 30	6/12-7/15/65, 8/8-9/17/65
E-25	15	6/16-7/15/65, 8/6-9/17/65
E-26	15	6/16-7/16/65
E-28	15	6/15-7/16/65
E-29	15, 30	6/14-7/15/65
E-30	15	6/14-7/15/65
E-31	15. 30, 45	6/14-7/15/65
E-33	15	4/21-9/15/65
E-34	5, 7, 9, 11, 13, 14, 16, 18, 20, 22	7/29-8/12/65

* Record length averages about 60% of total occupancy times.

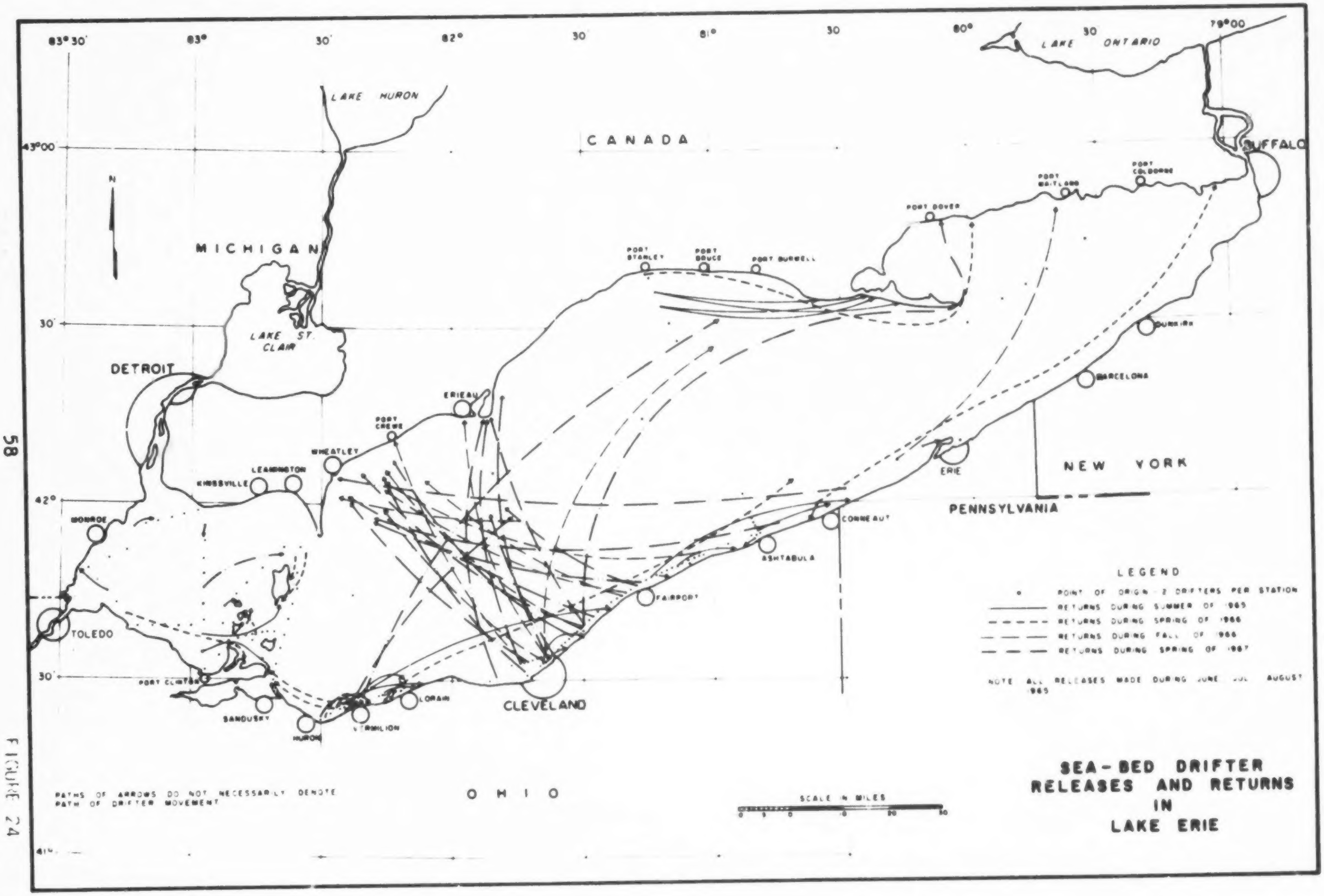
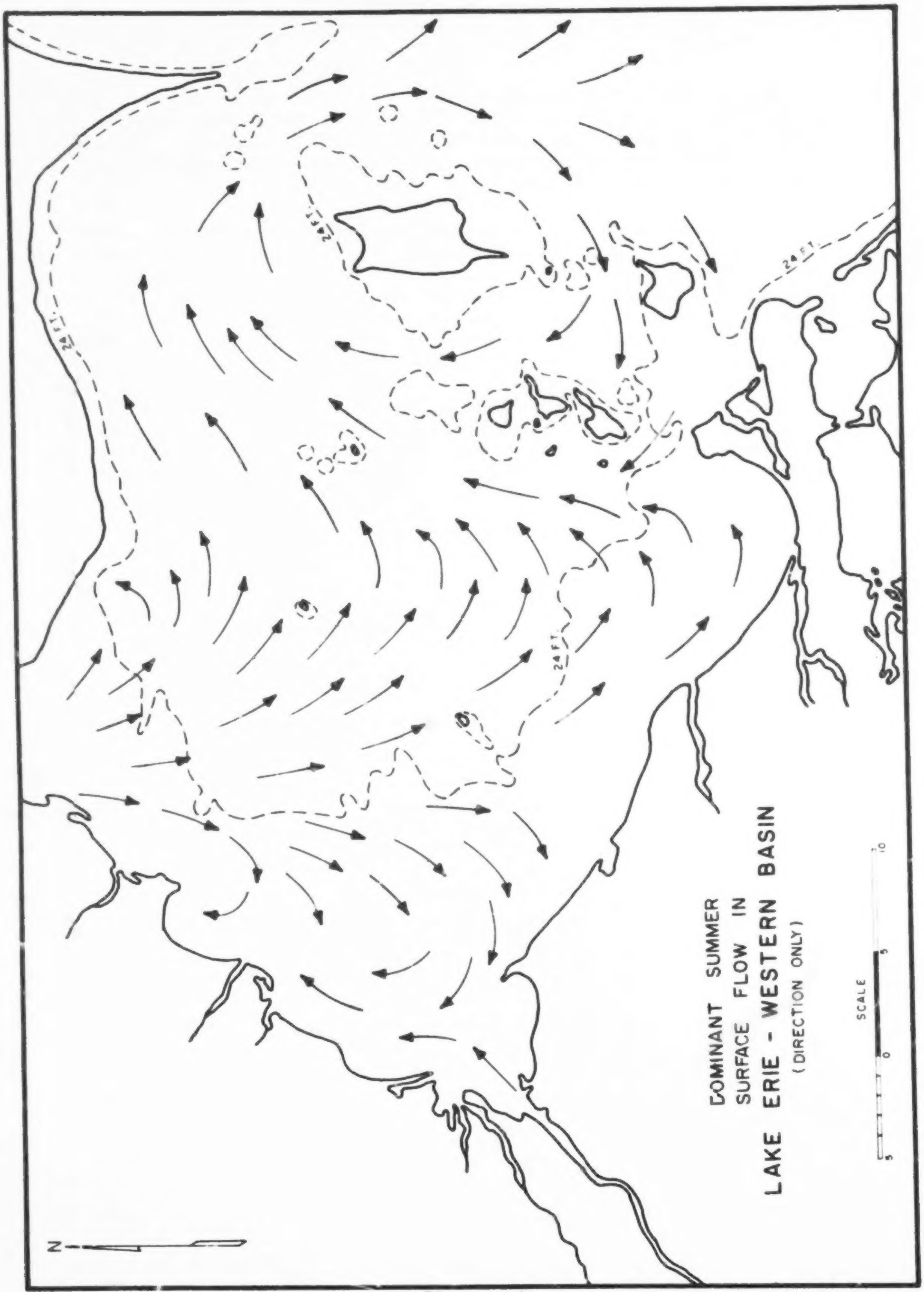

SEA-BED DRIFTER
RELEASES AND RETURNS
IN
LAKE ERIE
LEGEND
● POINT OF ORIGIN - 2 DRIFTERS PER STATION
—— RETURNS DURING SUMMER OF 1965
- - - RETURNS DURING SPRING OF 1966
— — RETURNS DURING FALL OF 1966
— — RETURNS DURING SPRING OF 1967
NOTE ALL RELEASES MADE DURING JUNE JUL AUGUST 1965
PATHS OF ARROWS DO NOT NECESSARILY DENOTE PATH OF DRIFTER MOVEMENT
SCALE IN MILES
0 5 10 20 30
N
83°30'
83°
30'
82°
30'
81°
30
80°
30
79°00
43°00
30'
42°
30'
41°
LAKE HURON
LAKE ONTARIO
CANADA
MICHIGAN
LAKE ST. CLAIR
DETROIT
NEW YORK
PENNSYLVANIA
OHIO
BUFFALO
PORT COLBORNE
PORT MAITLAND
PORT DOVER
PORT STANLEY
PORT BRUCE
PORT BURWELL
DUNKIRK
BARCELONA
ERIE
CONNEAUT
ASHTABULA
FAIRPORT
CLEVELAND
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
TOLEDO
MONROE
KINGSVILLE
LEAMINGTON
WHEATLEY
PORT CREWE
ERIEAU

FIGURE 24

352<


24 FT.
24 FT.
24 FT.
24 FT.
SCALE
5
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5
10
N

DOMINANT SUMMER SURFACE FLOW IN LAKE ERIE - WESTERN BASIN (DIRECTION ONLY)

FIGURE 25

353<

changes in wind direction and intensity. The effect of strong winds on surface circulation is to essentially skim the surface water and move it in the direction toward which the wind is blowing. Thus with a sufficiently strong wind most of the surface water, except along the windward shore, may move in the same direction.

Surface flow tells nothing about bottom circulation. In summer bottom currents in much of the western basin of Lake Erie are similar to surface currents, being dominated by the Detroit River inflow (Figure 26). However, in the island area the bottom currents are often the reverse of the surface currents with a counter-clockwise flow around the islands. The metering station (E-19) in Pelee Passage showed a dominant northwestward movement of water at a depth of 30 feet between the months of April and August 1965. Three days of measurement at 30 feet in South Passage (E-18) showed a dominant eastward movement. In late August and September in Pelee Passage the bottom flow had reversed, indicating that it had then become like the surface flow. Apparently lake cooling is important in establishing a top to bottom uniformity of dominant circulation. The dominant annual bottom flow may be clockwise around Pelee Island. Seabed drifter data tend to support this.

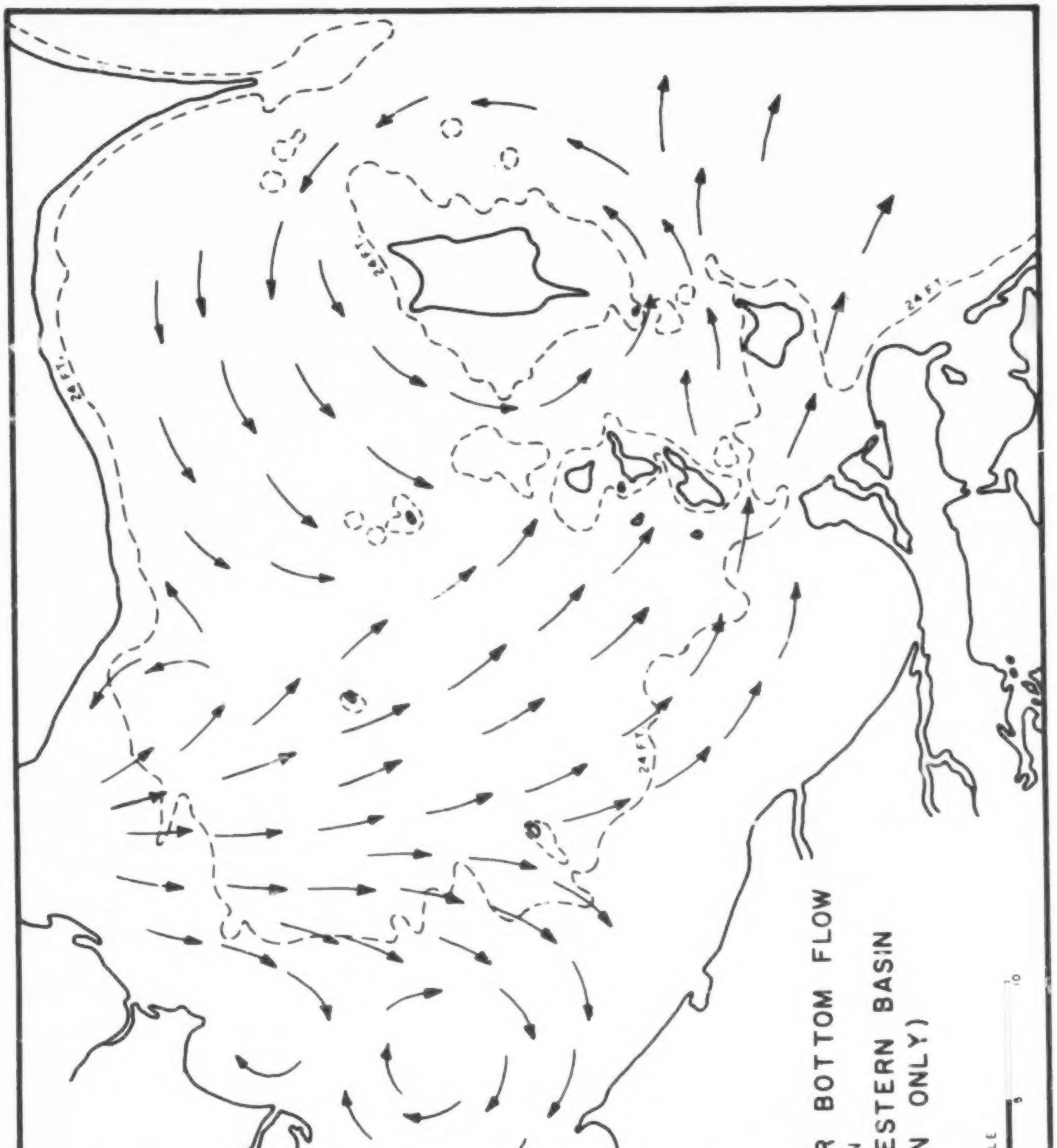
Records of currents at station E-34, one-half mile north of the Toledo water intake crib, during the summer of 1965 showed a dominant movement northwestward, compatible with the clockwise eddy movement in the Toledo-Monroe area.

Like the surface movement, bottom currents can also be changed by the wind, although it probably takes a stronger wind to create a major change of pattern. With very strong winds, which cause major changes of water level, the bottom currents are essentially the reverse of surface currents. This means, for example, that a strong westerly wind will cause bottom currents toward the west and a strong easterly wind will cause bottom currents to shift toward the east. Continuity considerations demand that subsurface reversals occur.

In the western basin water movements are not all so simple as described above. Seiches and changing winds complicate the patterns which occur at any particular time. An ice cover will enable the existence of a more or less stable pattern which should be similar to the dominant pattern of summer surface flow (Figure 25).

The probable surface and bottom flows under different strong wind conditions are shown in Figures 27 through 32. The western basin water apparently will show these kinds of responses year-round in the ice-free period. However, the reverse response in bottom waters apparently becomes less in fall and winter.

The most significant effects of current patterns in the western basin are:


24 FT.
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SCALE
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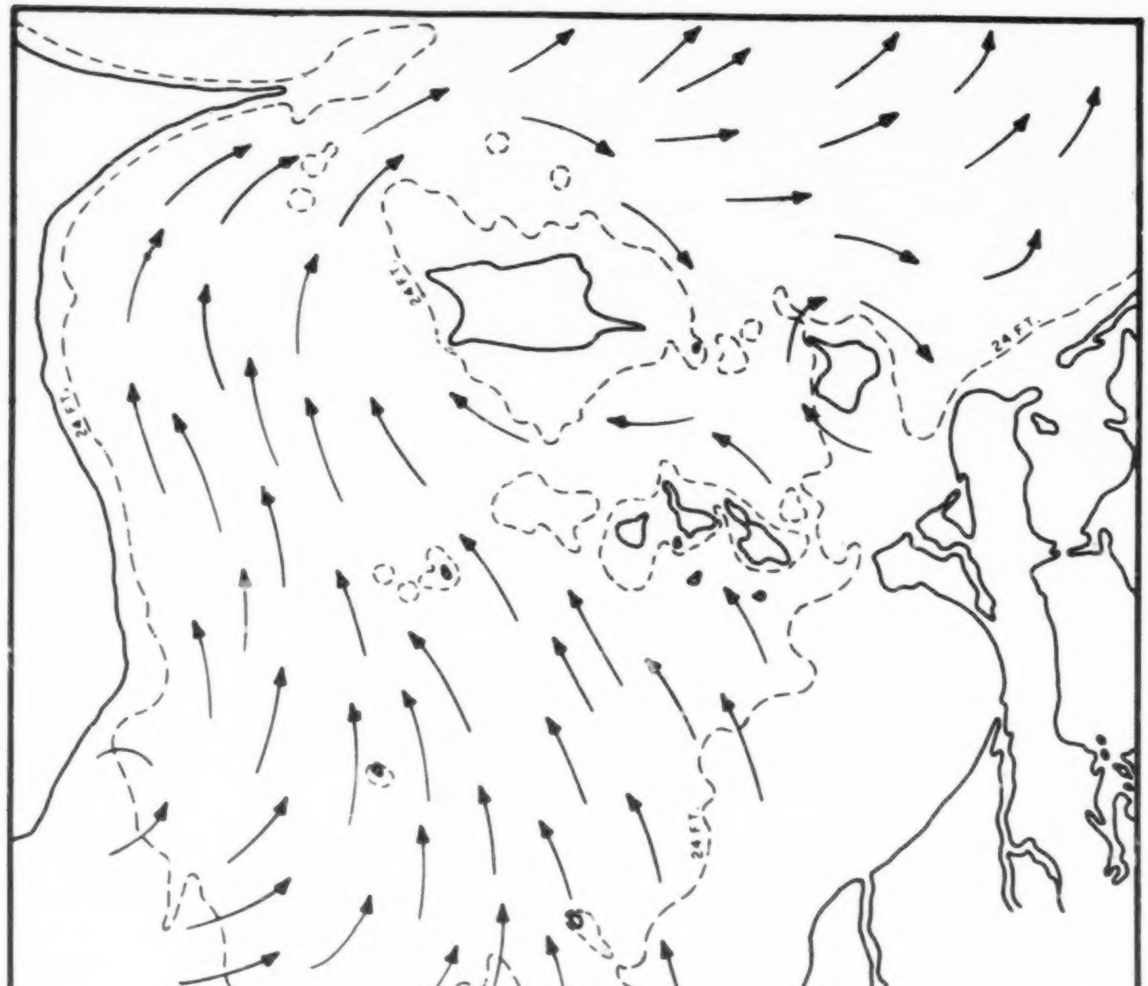
DOMINANT SUMMER BOTTOM FLOW
IN
LAKE ERIE - WESTERN BASIN
(DIRECTION ONLY)

FIGURE 26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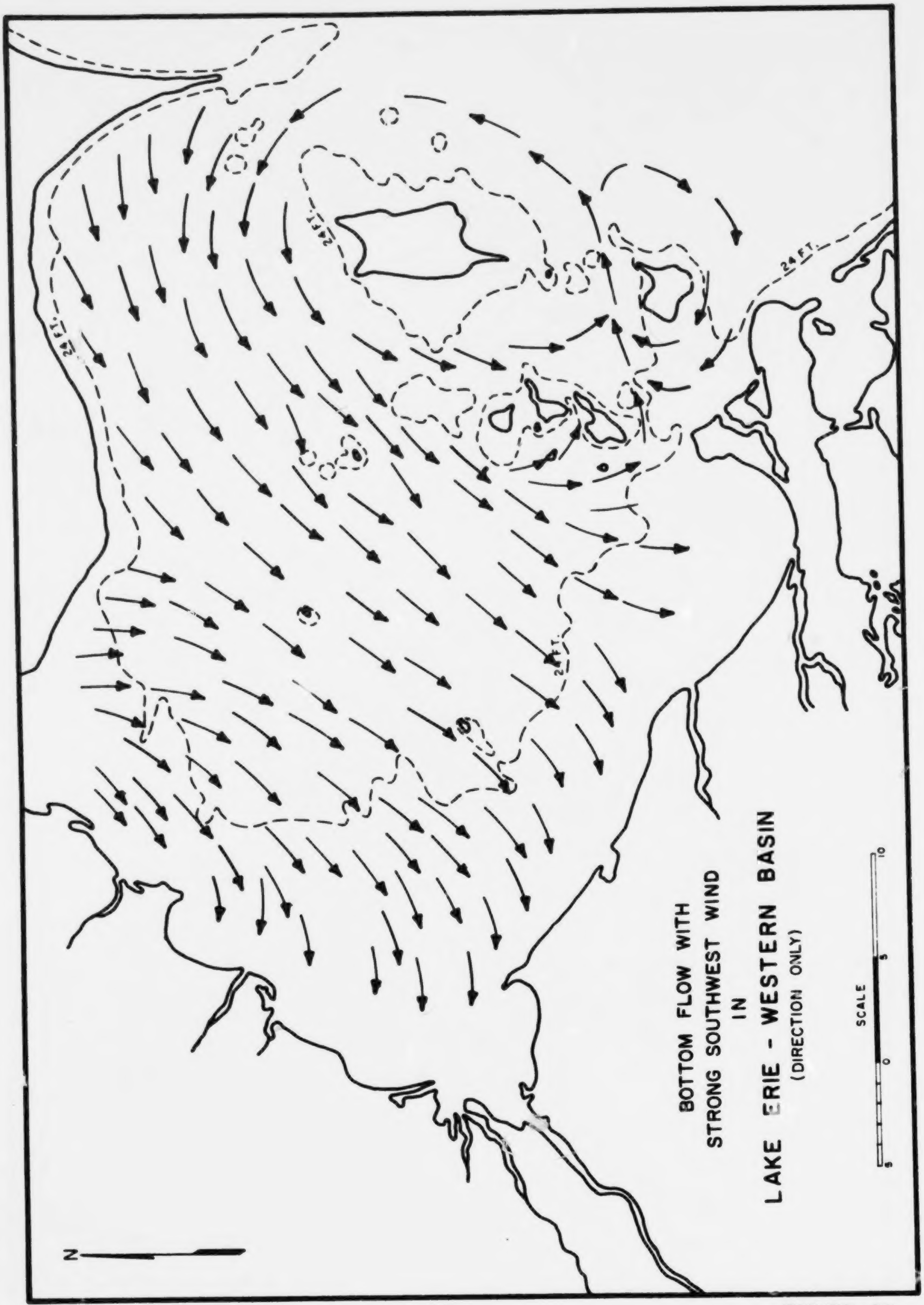
SURFACE FLOW WITH STRONG SOUTHWEST WIND IN LAKE ERIE – WESTERN BASIN (DIRECTION ONLY)

FIGURE 27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24 FT.
24 FT.
SCALE
5
0
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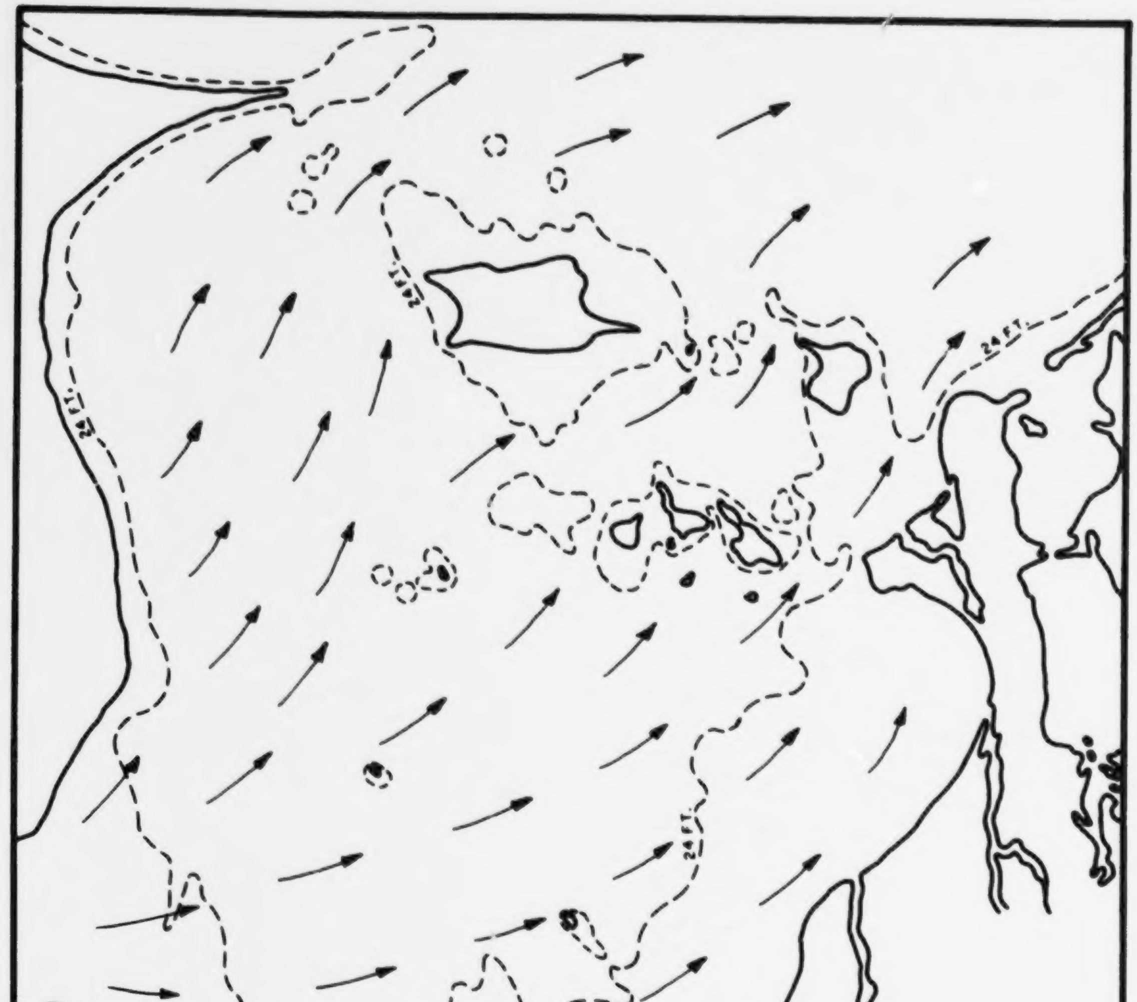
10
N

BOTTOM FLOW WITH
STRONG SOUTHWEST WIND
IN
LAKE ERIE - WESTERN BASIN
(DIRECTION ONLY)

FIGURE 28


24 FT.
24 FT.
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24 FT.
SCALE
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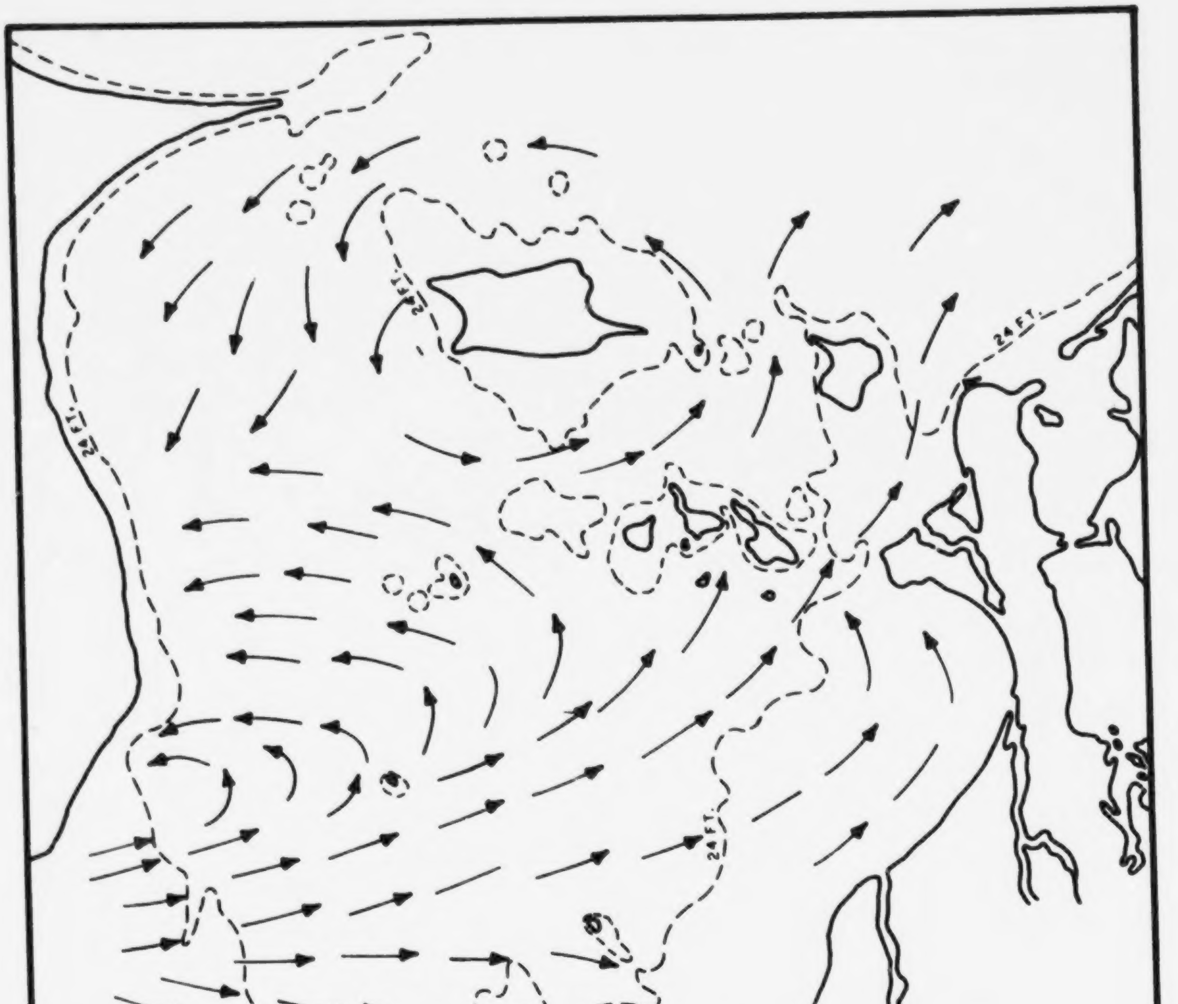
SURFACE FLOW WITH STRONG NORTHWEST WIND IN LAKE ERIE - WESTERN BASIN (DIRECTION ONLY)

FIGURE 29


24 FT.
24 FT.
24 FT.
24 FT.
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SCALE
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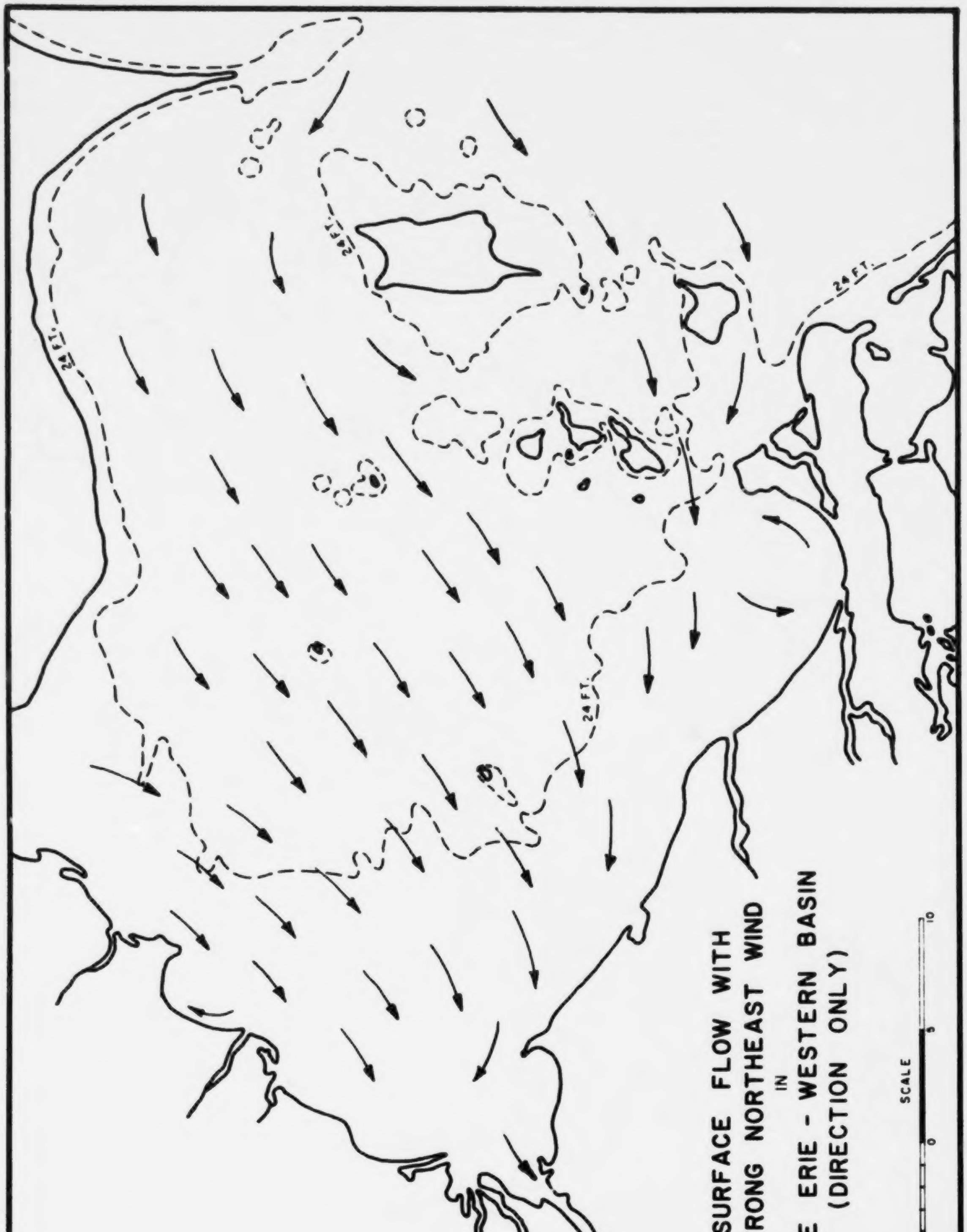
BOTTOM FLOW WITH
STRONG NORTHWEST WIND
IN
LAKE ERIE - WESTERN BASIN
(DIRECTION ONLY)

FIGURE 30


24 FT.
24 FT.
24 FT.
24 FT.
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SCALE
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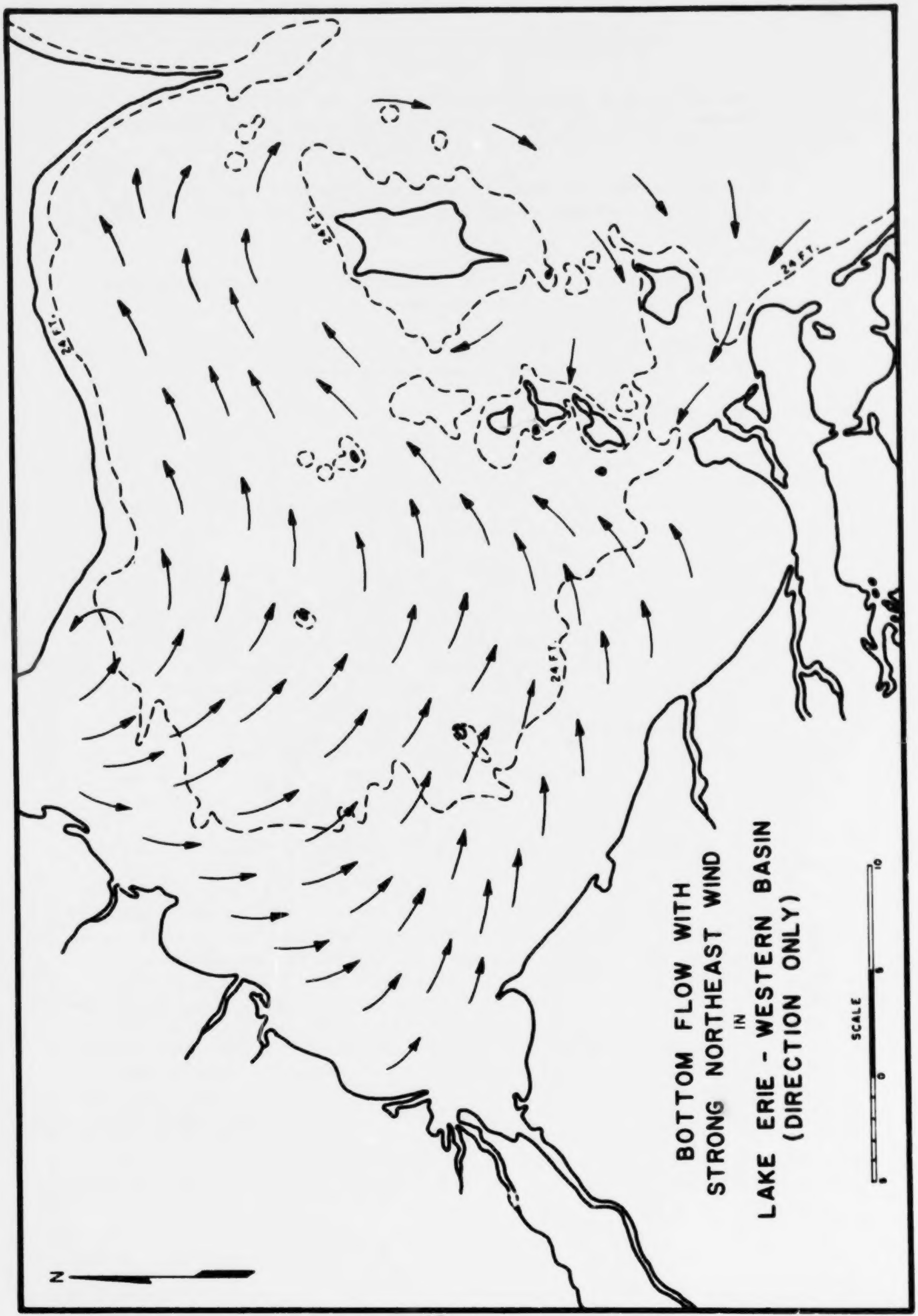
10

SURFACE FLOW WITH STRONG NORTHEAST WIND IN LAKE ERIE - WESTERN BASIN (DIRECTION ONLY)

FIGURE 51

360<


24 FT.
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24 FT.
24 FT.
SCALE
0
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N

BOTTOM FLOW WITH
STRONG NORTHEAST WIND
IN
LAKE ERIE - WESTERN BASIN
(DIRECTION ONLY)

FIGURE 32

1. Concentrations of contaminants from the Detroit, Raisin, and Maumee Rivers may build up along the west shore under the conditions of dominant flows, both surface and bottom.

2. Concentrations of contaminants may similarly build up to even higher values under ice cover since wind then has less effect.

3. Winds cause mixing and redistribution of contaminants over the entire basin in ice-free periods.

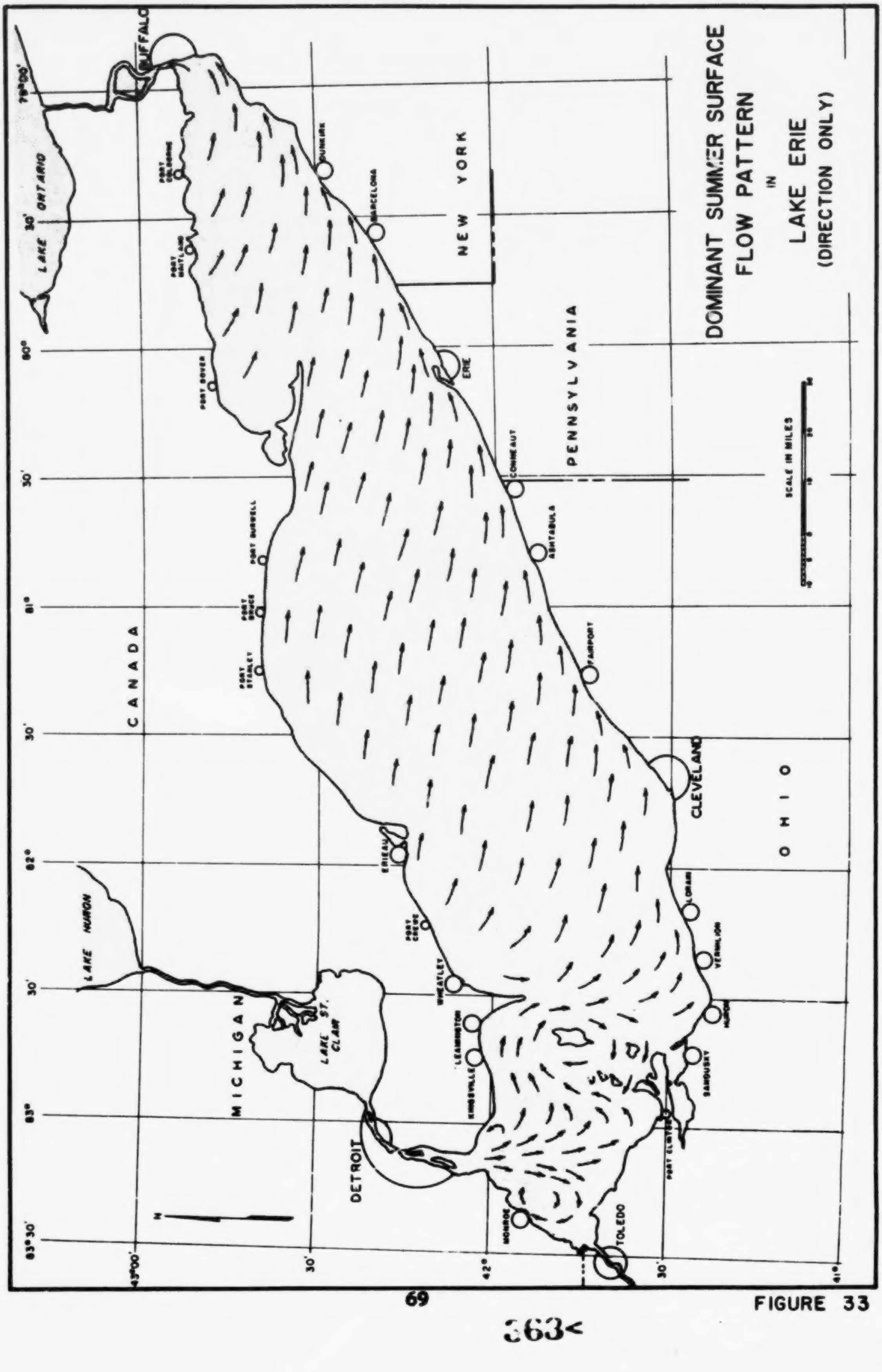
4. A portion of central Lake Erie water may recirculate in and around the island area of the western basin.

CENTRAL BASIN CIRCULATION

The effect of wind is over-riding in the water circulation of the central basin of Lake Erie. The orientation of the basin, with its long axis essentially parallel to the prevailing southwesterly winds makes this effect especially important.

The predominant summer surface water movement in central Lake Erie is as illustrated in Figure 33, based on the results of drift card, drift bottle, and drogue studies made by several other agencies. This pattern of surface movement has been determined from investigations carried out primarily during the summer months. The pattern should be similar for winter months but with a decided shift to movement more toward the southeast and south as a result of the more frequent occurrence of northwesterly winds. It should be noted that surface currents do not exactly parallel the wind direction but move somewhat to the right of it because of the Coriolis effect. It should also be understood that the predominant pattern is essentially that of resultant movement over an extended period, and at any one time, surface movement may be greatly different or even reversed, responding quickly to wind changes.

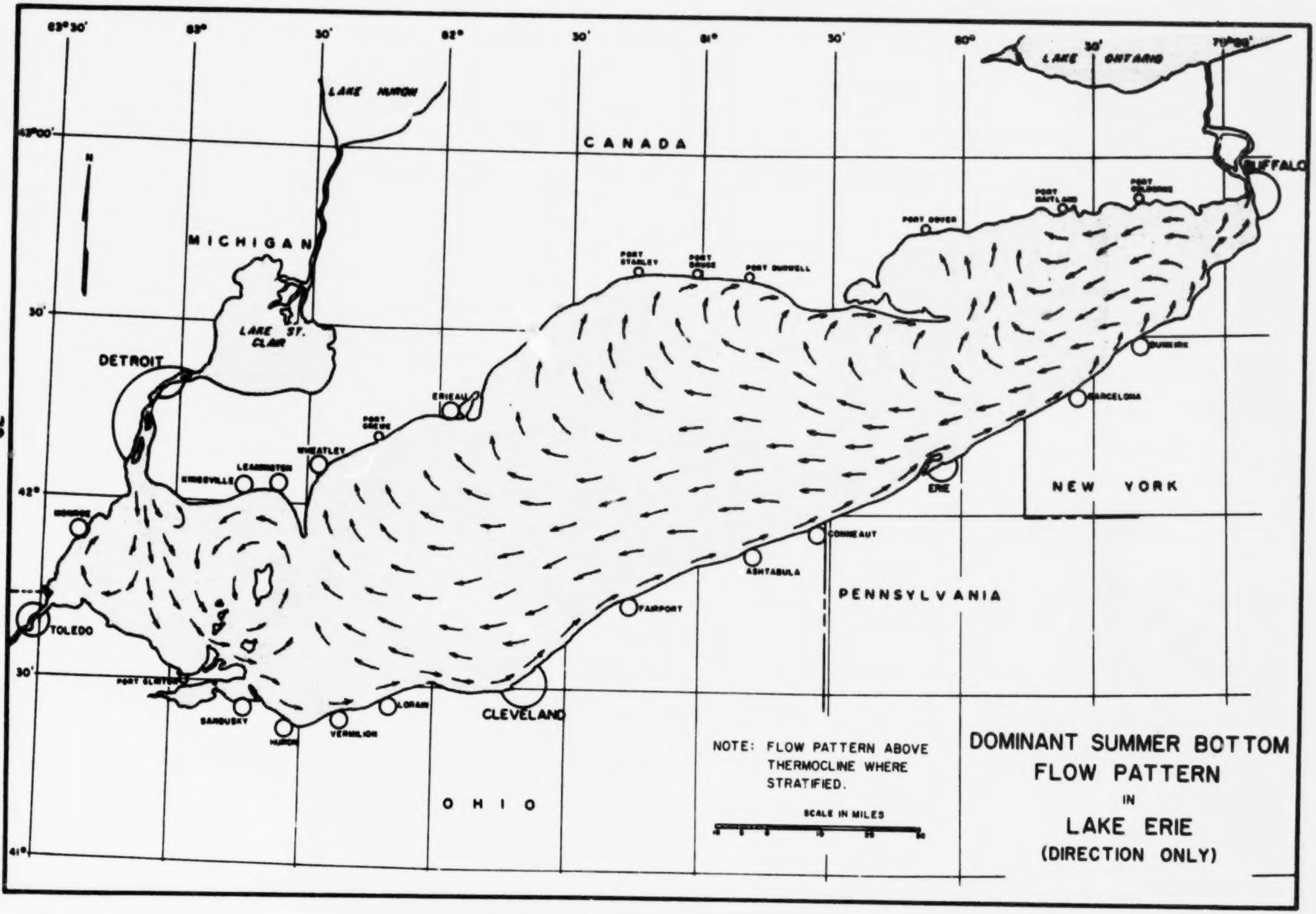
Bottom currents in central Lake Erie are not similar to surface currents. Because surface currents are generally moving water in much greater quantity than can be removed from the basin, the balancing movement must be subsurface and essentially a return flow over most of the basin, responding less quickly to wind changes. The predominant bottom flow pattern for summer is shown in Figure 34. In this case bottom flow means the motion at the lake bottom in unstratified water, but where the lake is thermally stratified it means the predominant movement at the bottom of the epilimnion. It is this bottom flow, between 30 to 60 feet below water level, that the metering program in the central basin of Lake Erie has measured. The stations at which it was measured were E-1 through E-11 (Figure 23). Table 7 lists, in brief, examples of some of the monthly flows at these stations in terms



DOMINANT SUMMER SURFACE FLOW PATTERN IN LAKE ERIE (DIRECTION ONLY)

LAKE ONTARIO
BUFFALO
PORT COLBORNE
PORT MAITLAND
DUNKIRK
BARCELONA
NEW YORK
PORT DOVER
ERIE
PENNSYLVANIA
CONNEAUT
ASHTABULA
PORT BURWELL
PORT BRUCE
PORT STANLEY
FAIRPORT
CANADA
CLEVELAND
OHIO
ERIEAU
LORAIN
VERMILION
PORT CREWE
WHEATLEY
LEAMINGTON
KINGSVILLE
HURON
SANDUSKY
PORT CLINTON
LAKE HURON
MICHIGAN
LAKE ST. CLAIR
DETROIT
MONROE
TOLEDO
N
SCALE IN MILES
79°00'
30'
80°
30'
81°
30'
82°
30'
83°
83°30'
43°00'
30'
42°
30'
41°

FIGURE 33


83°30'
83°
30'
82°
30'
81°
30'
80°
30'
79°00'
43°00'
30'
42°
30'
41°
LAKE HURON
LAKE ONTARIO
CANADA
MICHIGAN
LAKE ST. CLAIR
DETROIT
N
TOLEDO
MONROE
KINGSVILLE
LEAMINGTON
WHEATLEY
ERIEAU
PORT STANLEY
PORT BRUCE
PORT BURWELL
PORT DOVER
PORT MAITLAND
PORT COLBORNE
BUFFALO
DUNKIRK
BARCELONA
NEW YORK
ERIE
CONNEAUT
ASHTABULA
PENNSYLVANIA
FAIRPORT
CLEVELAND
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
OHIO
SCALE IN MILES

NOTE: FLOW PATTERN ABOVE THERMOCLINE WHERE STRATIFIED.

DOMINANT SUMMER BOTTOM
FLOW PATTERN
IN
LAKE ERIE
(DIRECTION ONLY)

FIGURE 34

TABLE 7

CURRENT FLOWS AT CENTRAL BASIN METER STATIONS
(station locations on Figure 4-7)

Station	Depth (ft.)	June 1964			December 1964		
		Net. Dir. from	Net. Vel. cm/sec	Avg. Vel. cm/sec	Net Dir. from	Net Vel. cm/sec	Avg. Vel. cm/sec
E 1	30	118°	0.80	11.4	277°	1.41	5.6
E 2	30	--	--	--	183°	0.83	10.4
E 3	30	--	--	--	315°	1.53	10.6
E 4	50	--	--	--	257°	2.44	7.2
E 5	30	70°	4.15	8.8	--	--	--
E 6	30	141°	1.49	5.9	87°	1.86	9.8
E 7	30	225°	--	--	--	--	--
E 7	50	--	--	--	47°	0.52	6.5
E 8	30	77°	2.31	6.8	--	--	--
E 9	30	82°	1.82	10.7	--	--	--
E 11	30	112°	6.52	10.9	--	--	--

Note: To convert velocities to ft./sec. multiply by .033.

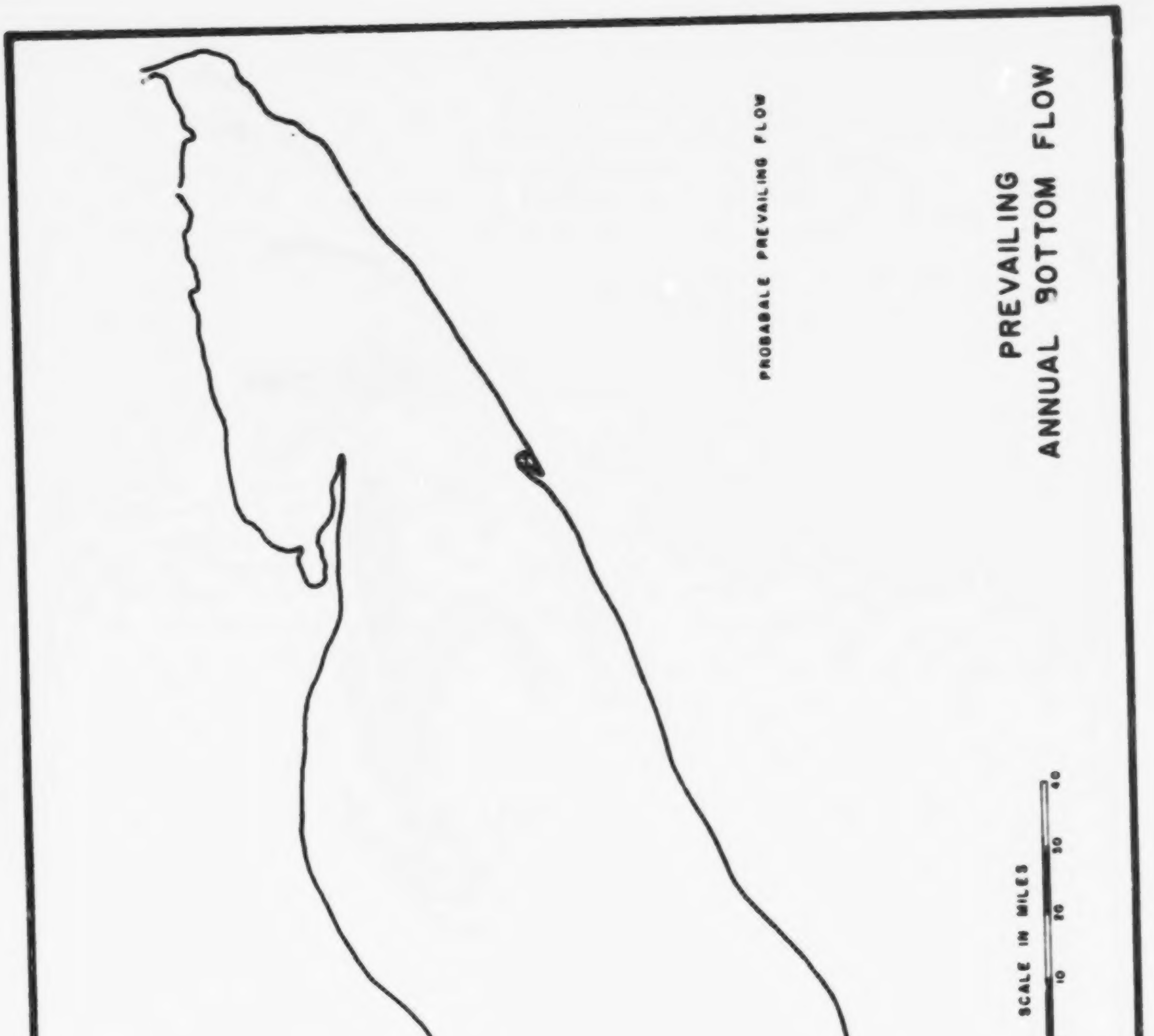
of net direction, net velocity, and average velocity of all measurements. Figure 35 based on both current meter and drifter data, shows the dominant annual bottom flow in Lake Erie. Note that this is a slightly different pattern from that of Figure 34 showing summer flow above the thermocline.

The metering program did not show, except during occasional periods of hypolimnetic upwelling, what was happening below the thermocline. There is no reason to believe that a predominant horizontal circulation pattern exists in the hypolimnion. However, high velocity currents (up to 2 ft/sec.) have been measured, during storms, in the hypolimnion. These are brought about during up and downwelling when the hypolimnion water is forced to slide around in the basin. This phenomenon becomes increasingly significant in late summer and early fall when the hypolimnion is thin and sharply divided from the epilimnion.

Bottom currents near shore are pronounced in summer and are quite different from bottom currents offshore, indicating a separate system of water movement. Seabed drifter returns from the summer of 1965 showed that (1) releases more than three miles from the south shore produced no returns, (2) releases less than three miles from shore gave many returns, (3) drifters moving westward averaged only about one mile of travel, and (4) drifters moving eastward averaged nearly 12 miles of travel. These results indicate that, especially in summer, there is a pronounced eastward movement of nearshore water (Figure 35). This has been substantiated by current meter measurements at stations E-20, E-22, E-23, E-25, E-26, and E-30 (Figure 23). Water temperature structure also supports this conclusion with a spring and summer band of warmer water near the south shore.

Dye studies along the south shore of the central basin in the summer of 1965 showed in general that surface water within the nearshore zone, while moving parallel to shore, also tended to move toward shore. This was easily noticeable when movement was toward the east. Movement toward the west at times showed a simultaneous movement away from shore but was not so pronounced.

Transport of sediments near the water line along the south shore of the central basin is not necessarily indicative of prevalent flow of water. For example, from Avon Point westward, beach sediment accretion patterns indicate a general drift toward the west. This results from wave action in the nearshore zone which is stronger from the northeast. Sediments are moved toward the west during the intermittent periods of northeasters. The slower but much more prevalent water motion toward the east is unable to transport the sediments. From Avon Point eastward the nearshore sediment drift is toward the east, the same as prevailing water flow, because increased westerly fetch makes waves from that direction more effective.


PREVAILING
ANNUAL BOTTOM FLOW
PROBABALE PREVAILING FLOW
SCALE IN MILES
10
0
10
20
30
40
N

367<

FIGURE 35

A different type of situation exists along the north shore of the central basin. The zone of separate nearshore flow is limited in summer, if it exists at all. Temperatures indicate that the nearshore water is cooler throughout the summer than along the south shore. This implies removal of warm water and replenishment by lower waters.

Summer current metering data at stations E-7 and E-11 (Figure 23) show net motion from the south-southwest toward the Canadian shore of water at depths of 30 feet and below. Seabed drifters released off Port Stanley as far as nine miles offshore turned up on the beach far to the east. These also indicate a bottom water movement toward shore and to the east.

The Canadian shore of the central basin is more irregular than the south shore and the irregularity has a pronounced effect on wave action and beach drift along the shore. On the east side of Pelee Point the drift is toward the south-southwest, moving sediment to the tip of Pelee Point. Between Wheatley and Erieau, Ontario, the drift reverses and at Erieau it is toward the east. Along the eastern side of Pointe Aux Pins the drift is toward the south. Eastward the drift reverses again and at Port Stanley and eastward the drift is strongly toward the east. All of these drift phenomena are functions of wind and fetch and resulting wave force in the nearshore zone and are not necessarily reflecting prevailing nearshore water movement.

The most significant change in circulation in the central basin water in fall and winter is the disruption of the confining influences of water temperatures. Usually in September the surface waters of Lake Erie become nearly isothermal and by the first of October the thermocline has disappeared from the central basin. The higher temperatures which previously existed along the south shore disappear and there is no longer a density restriction to water movement. In effect then, the nearshore flow is more free to move water lakeward and cooler tributary water can under-run lake water. The bottom flow return circulation in mid-lake reaches to the lake bottom where the thermal barrier (thermocline) previously separated it from the lake bottom.

Seabed drifters tend to confirm a radical change in lake circulation in late fall. Many of the drifters released in the central basin near the south shore in the early summer of 1965 reappeared in the fall of 1966 and the spring and fall of 1967. There were no returns of consequence in the fall of 1965 and the summers of 1966 and 1967. The fall 1966 and later returns were unexpected but the consistency of the returns pattern in both space and time indicates that most of the drifters were probably carried across the lake and retransported during high velocity northerly and westerly winds. The probability of nearshore water crossing the lake along the bottom has been shown and it is likely that this is common in fall and winter.

In spring when the shore water warms to several degrees above the temperature of mid-lake water, the south shore nearshore flow zone is reestablished. A "thermal bar" (Rogers, 1965) may be created shortly after the spring thaw and warmer tributary discharges may be even more confined to the nearshore zone. This condition can exist only when a 4°C isotherm exists with colder water on one side and warmer on the other.

Along the northern shore in fall and winter the water movement probably is not greatly different than in summer, but supporting data are lacking.

Drogue studies near shore, off western Cleveland in August 1964 showed that a dense pattern of drogues resulted in little dispersion, indicating that dispersion of inputs may be slow.

Conclusions which can be made regarding the pollutional aspects of currents in central Lake Erie are as follows:

1. Tributary and lake outfall discharges in spring and summer along the south shore tend to stay near shore and move eastward primarily as a result of the prevailing southwesterly winds.

2. In fall and early winter the same kinds of discharges can under-run the lake water and be distributed over the basin.

3. Contaminants reaching more than three miles off shore are likely to be distributed over the entire basin.

4. A vertical circulation in mid-lake exists year-round with easterly surface flow and westerly moving bottom flow.

5. The hypolimnion of mid-summer does not have a net circulation flow but does have occasional high-velocity flow as a result of up and downwelling. This flow is capable of resuspending bottom sediments.

6. Surface waters in summer move toward the south shore and away from the north shore.

7. Velocities at any level can be up to 2 feet per second during storms.

8. Vertical turbulent mixing is very effective in storms.

9. Dispersion is slow and limited horizontally.

EASTERN BASIN CIRCULATION

Water circulation in the eastern basin is also primarily wind-controlled. Flow-through currents become important near the headwaters of the Niagara River but otherwise are insignificant.

The surface water movement in the eastern basin appears to be similar to that of the central basin in that the dominant flow is eastward and toward the south shore (Figure 33). The predominant surface flow over most of the eastern basin is probably similar throughout the year but with a shift more toward the south in fall and winter.

The surface flow in the nearshore zone along the south shore is predominantly to the east, but an essentially independent summer zone such as in the central basin is not a persistent feature and is probably most important in spring and early summer.

Subsurface flow in summer, according to current meter measurement, is somewhat confused at and above the thermocline. It appears to be predominantly toward the west at stations E-12, E-15, and E-17, but toward the east at E-14 and toward the northwest at E-16 (Figure 23). The resulting areal pattern is apparently as shown in Figure 34 for the bottom of the epilimnion in stratified water. This pattern is often disrupted and confused by commonly occurring internal thermoclinal waves. Below the thermocline another system of circulation exists. Just below the thermocline the predominant motion is apparently similar to that just above the thermocline. It appears that a vertical circulation may be important in the hypolimnion and that the lake bottom currents are near the reverse of currents just below the thermocline with a horizontal clockwise motion superimposed. Velocities at the bottom are ordinarily very slow however, increasing upward. Upwelling in the eastern basin does not cause high-velocity currents as it does in the central basin.

The thermocline disappears in the eastern basin ordinarily in November. The circulation changes to one system with a predominant southeastward moving surface flow and a westward moving current at the lake bottom again with a clockwise bottom flow superimposed. Velocities decrease with depth and are probably insignificant at the bottom except within a few miles of shore in shallower waters. The assumed annual prevailing flow at the bottom is shown in Figure 35.

In summary the eastern basin circulation is similar to the central basin and in general is as follows:

1. A vertical circulation exists above the thermocline in summer, dominantly eastward at the surface and westward in the lower part of the epilimnion.

2. A vertical circulation, similar to above, exists, top to bottom in early winter and perhaps all winter with very slow movement at the bottom in deeper water.

3. Internal waves on the thermocline lead to turbulent mixing in the epilimnion and cause currents in haphazard directions.

4. Discharges from tributaries are carried to deep water quickly at nearly all times of the year and a separate nearshore current is limited to spring and early summer.

5. Discharges not caught in the Niagara outflow can be distributed over the entire basin.

6. Surface water moves toward the south shore and away from the north shore and vice versa at depth.

7. Discharges into upper waters of either the central and eastern basins may at one time or another be found nearly anywhere in either of these basins.

8. Water below the level reached by the summer thermocline may be trapped there for long periods, on the order of a year or more.

GENERAL OBSERVATIONS

During periods of quiet weather, rotational currents, related to the inertial period and internal waves, are created in the central and eastern basins with no net transport involved. These are particularly evident in summer, becoming rather rare in winter.

It appears that, at least in summer, the bulk of the drainage from Lake Erie is from surface water, much of which has been moved to, and is moving along the south shore of the central and eastern basins. This tends to create two retention systems, one of which (south shore) is much shorter than the theoretical detention time, and one which is much longer (mid-lake).

CHAPTER 3

LAKE ERIE CHEMICAL CHARACTERISTICS

SEDIMENT CHEMISTRY

In order to gain some knowledge of the composition of lake bottom sediments, 16 samples from the western basin, 21 from the central basin, and 23 from the eastern basin were analyzed for the following constituents:

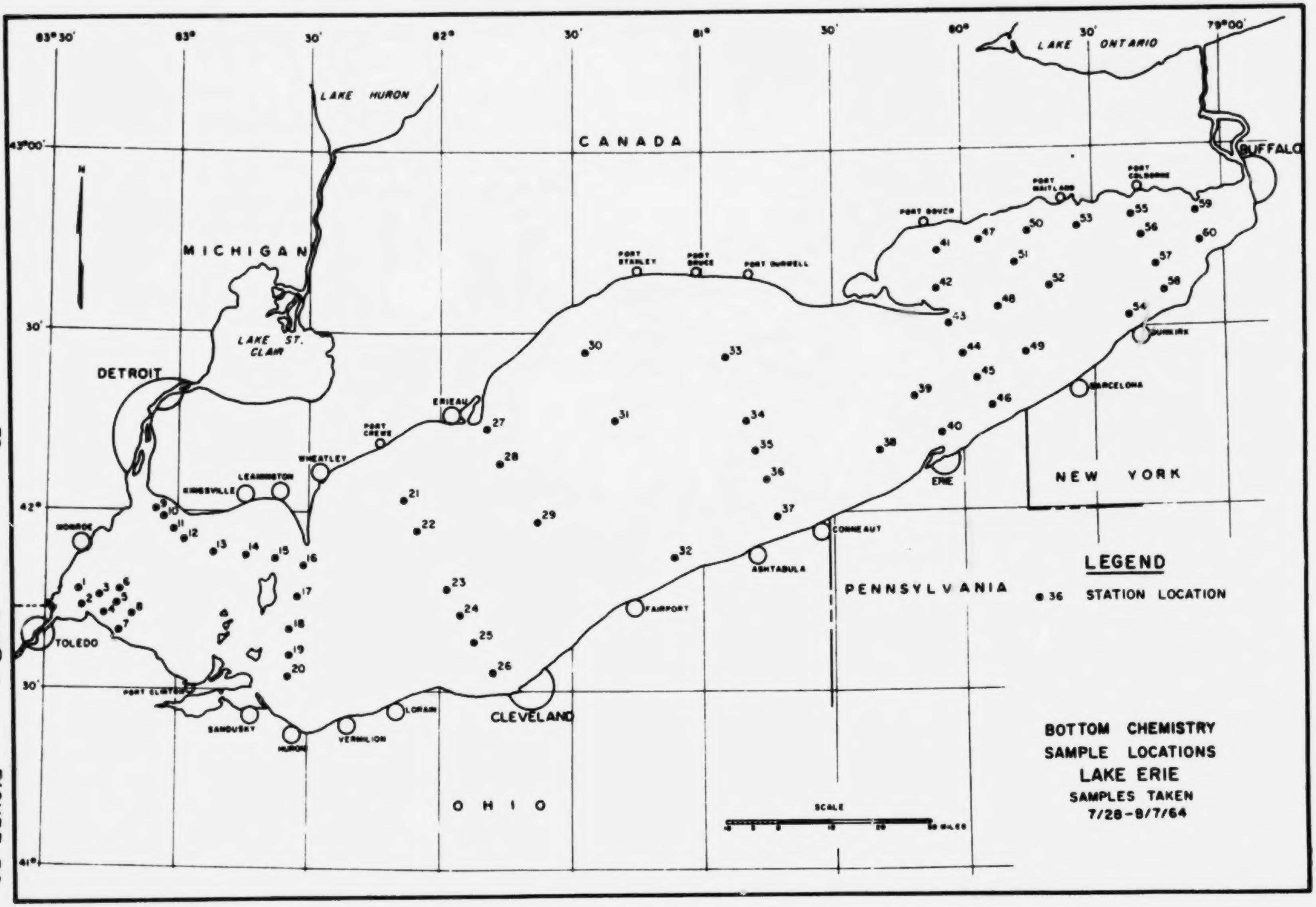
a. Total iron
b. Total phosphate
c. Sulfide
d. Ammonia nitrogen
e. Nitrate and nitrite nitrogen
f. Organic nitrogen
g. Volatile solids
h. Chemical oxygen demand

The samples were taken between July 28 and August 7, 1964. Sampling and analyses were not of sufficient density (Figure 36) to provide more than generalities as to areal extent of concentration ranges.

The results of bottom sediment analyses are presented to show the existence of substances and their abundance in each basin. The results are listed in Table 8 for the western basin, Table 9 for the central basin, and Table 10 for the eastern basin. The results are reported as milligrams per gram of sediment, oven dry weight. The data cannot be used to show rates of accumulation since the rates of sedimentation are not known.

TOTAL IRON

Total iron in the bottom sediments is similar in concentration in the western and central basins, averaging 33 to 35 mg/g. The concentration drops in the eastern basin to an average of 27 mg/g. To minimize the effects of erosion, total iron averages in the central and eastern basin were calculated from samples obtained from depths greater than 10 fathoms. Sources of iron in lake sediments are glacial deposits, soluble and colloidal inputs from basin tributaries, and from Corps of Engineers dredging of navigable channels and harbors. As an example of the latter, more than 70 million pounds of iron were removed from the Cuyahoga River and Cleveland Harbor during 1967 and deposited in offshore areas. Areal patterns of iron concentration are shown in Figure 37.


LAKE ONTARIO
LAKE HURON
CANADA
MICHIGAN
LAKE ST. CLAIR
DETROIT
BUFFALO
PORT COLBORNE
PORT MAITLAND
PORT DOVER
PORT STANLEY
PORT BRUCE
PORT BURWELL
ERIEAU
PORT CREWE
WHEATLEY
LEAMINGTON
KINGSVILLE
MONROE
TOLEDO
PORT CLINTON
SANDUSKY
HURON
VERMILION
LORAIN
CLEVELAND
FAIRPORT
ASHTABULA
CONNEAUT
ERIE
BARCELONA
DUNKIRK
NEW YORK
PENNSYLVANIA
OHIO
N
83° 30'
83°
30'
82°
30'
81°
30'
80°
30'
79°00'
43°00'
30'
42°
30'
41°
LEGEND
● 36 STATION LOCATION
SCALE
MILES
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

BOTTOM CHEMISTRY
SAMPLE LOCATIONS
LAKE ERIE
SAMPLES TAKEN
7/28-8/7/64

FIGURE 36

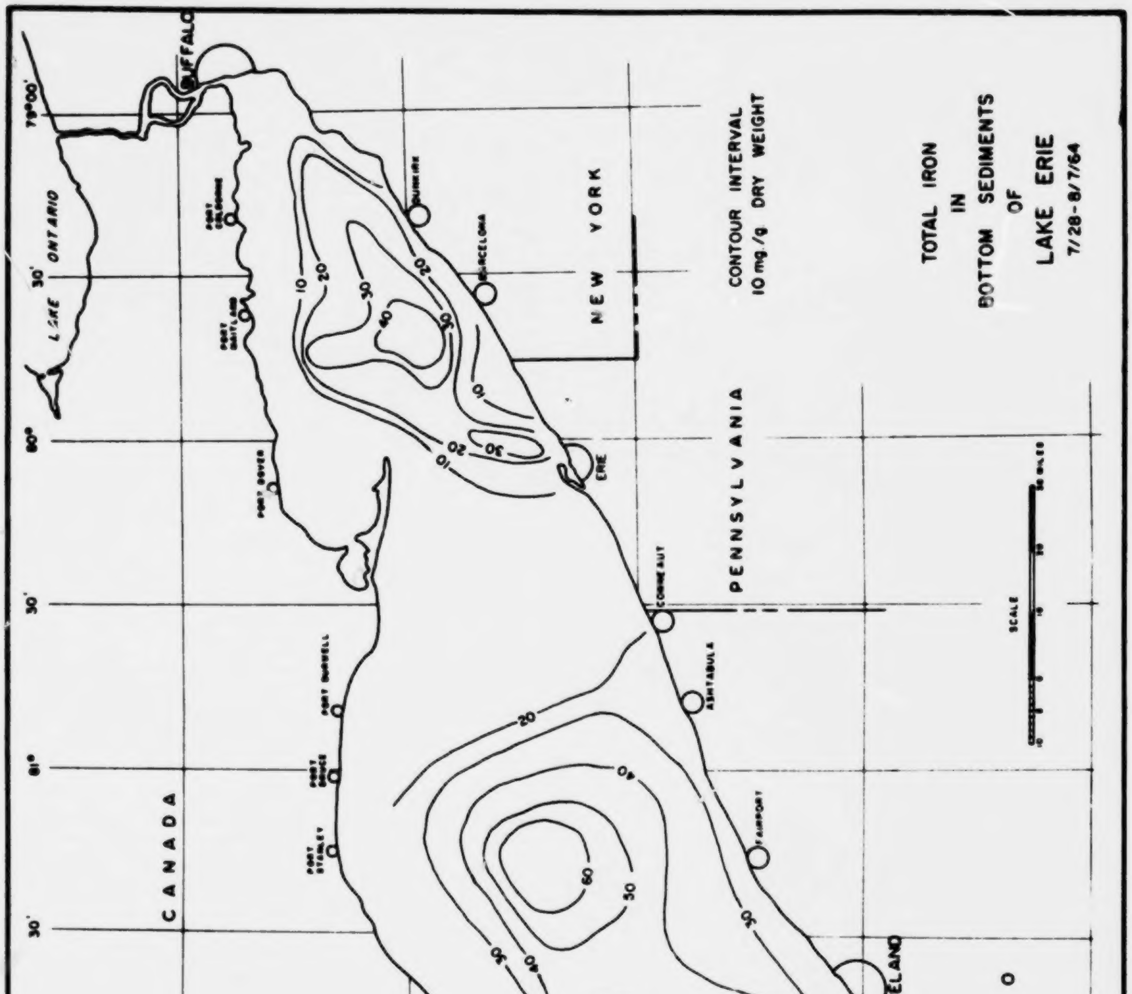

TOTAL IRON
IN
BOTTOM SEDIMENTS
OF
LAKE ERIE
7/28-8/7/64
CONTOUR INTERVAL
10 mg/g DRY WEIGHT
SCALE
LAKE ONTARIO
LAKE HURON
LAKE ST. CLAIR
CANADA
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
BUFFALO
DUNKIRK
BARCELONA
ERIE
CONNEAUT
ASHTABULA
FAIRPORT
CLEVELAND
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
TOLEDO
MONROE
DETROIT
KINGSVILLE
LEAMINGTON
WHEATLEY
ERIEAU
PORT STANLEY
PORT BRUCE
PORT BURWELL
PORT DOVER
PORT MAITLAND
PORT COLBORNE
79°00'
30'
80°
30'
81°
30'
82°
30'
83°
83°30'
43°00'
30'
42°
30'
41°
10
20
30
40
50
60
70
N

FIGURE 37

TOTAL PHOSPHATE

The general areal pattern of total phosphate (PO_4) concentrations (divide by 3 to obtain phosphorus concentration) is shown in Figure 38. The concentrations in the bottom sediments appear to decrease somewhat from west to east. The average for the western basin samples was 2.29 mg/l while the samples from the central basin averaged 1.95 mg/l, and those from the eastern basin averaged 1.51 mg/l. Highest values were found in the western basin as expected because of large inputs of phosphates to that basin. Progressively smaller concentrations were found in the central and eastern basins due to greatly reduced inputs. Augmentation of tributary phosphate inputs occurs from sedimentation of planktonic occluded phosphorus.

Recycling of phosphates from lake sediments to overlying waters will occur during summer stratification. However, the solubilized phosphates not depleted by algal metabolism will be reprecipitated again during fall turnover.

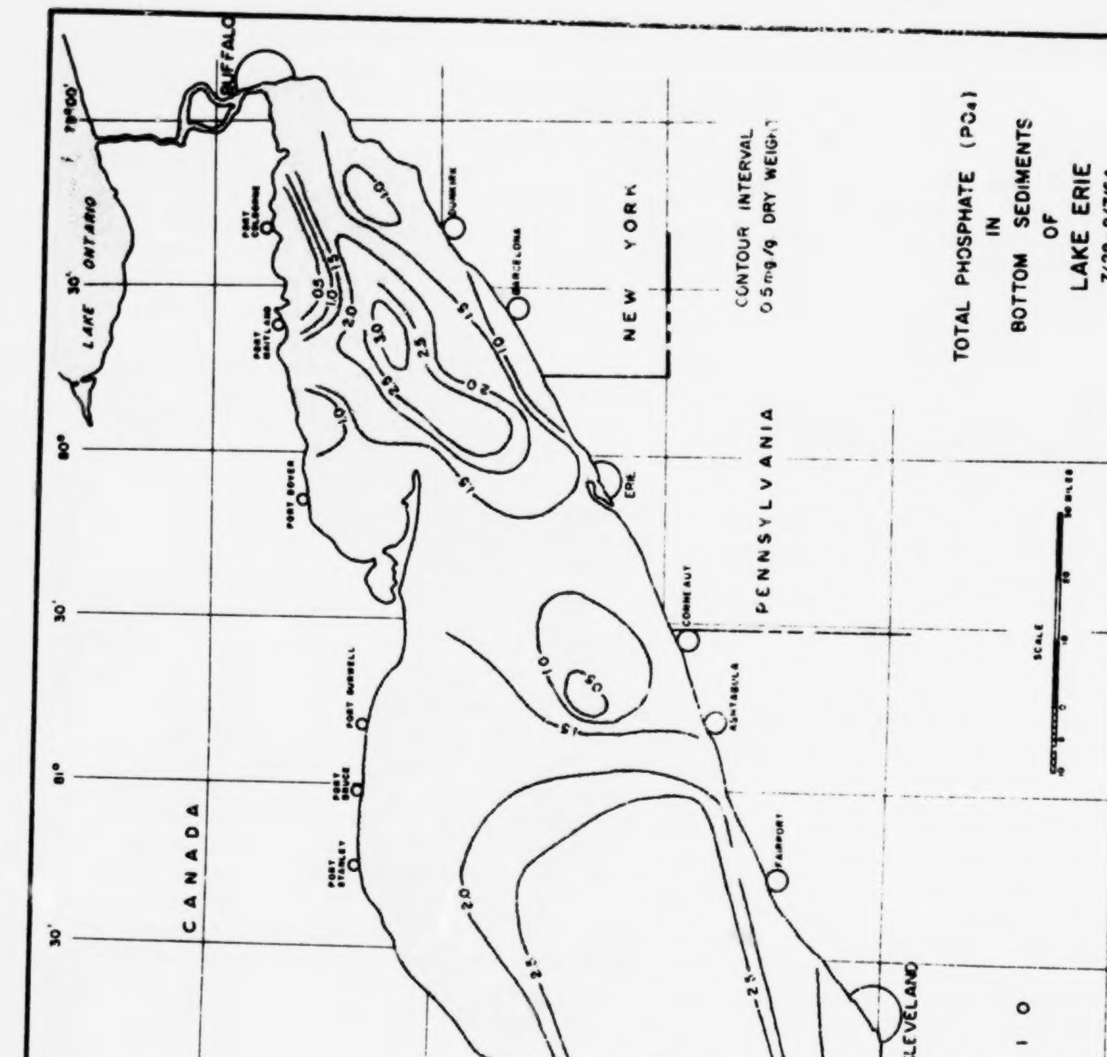
SULFIDE

Sulfide concentrations in bottom sediments averaged 0.23 mg/g in the western basin, 0.97 mg/g in the central basin, and 0.04 mg/g in the eastern basin. In addition to a much higher average, the central basin sediments showed a wide variation from 0.01 to 3.90 mg/g. The very high values in the central basin were found in the sediments below the hypolimnion which was characterized by low dissolved oxygen. The high concentrations result from low oxidation-reduction potentials exhibited by the sediments and overlying waters due to anaerobiasis. Under these conditions sulfate reduction to sulfide occurs. Anaerobiasis does not occur in the western and eastern basins. Consequently, low sulfide concentrations are found there. Figure 39 shows the general distribution of sulfides in Lake Erie sediments.

ORGANIC NITROGEN

Organic nitrogen is the nitrogen present in organic compounds. Natural nitrogen organic compounds are the result of plant and animal metabolism and decay. Relatively small amounts of synthetic nitrogen compounds may be expected to find their way to receiving waters.

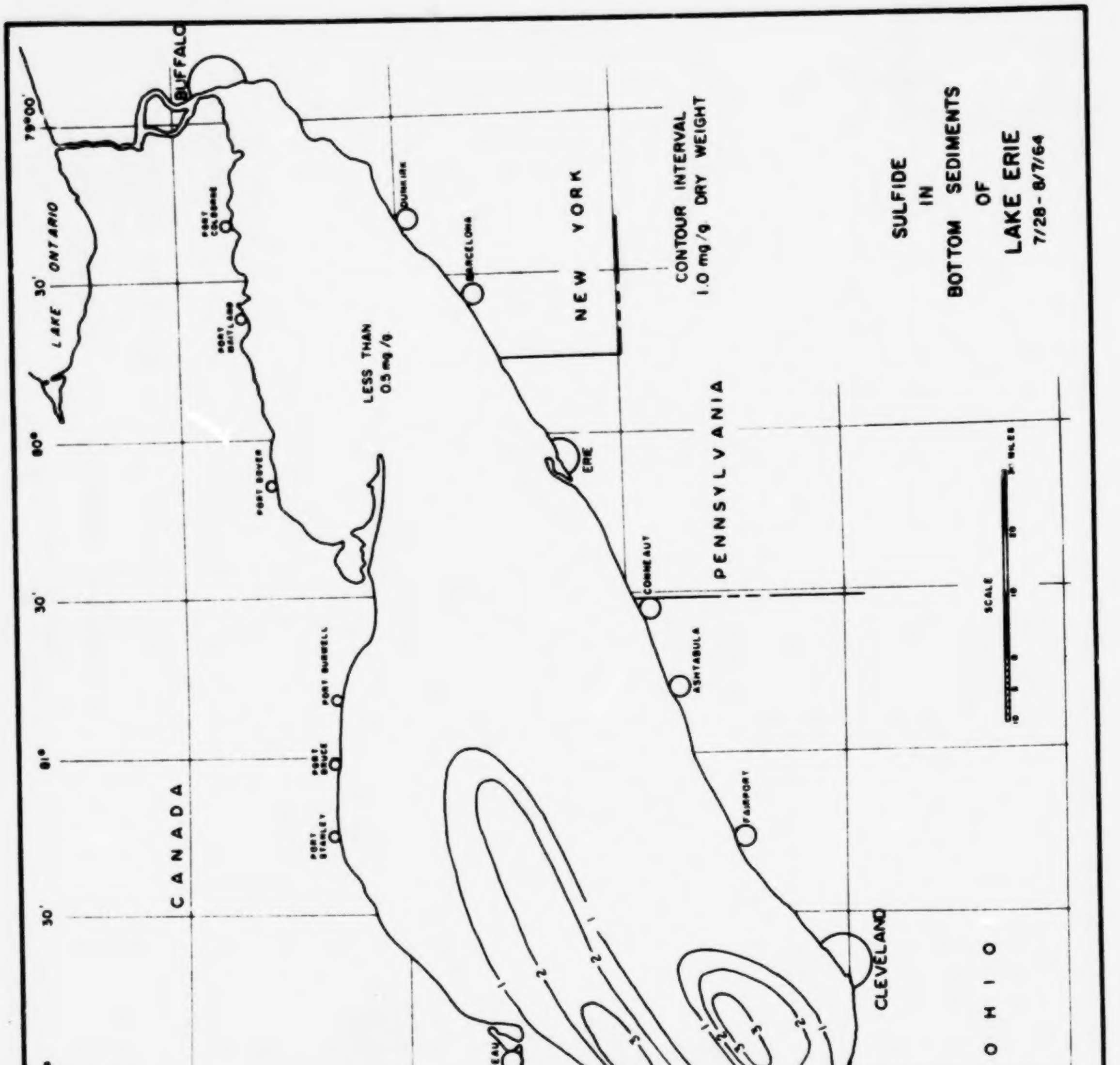
Organic nitrogen in the bottom sediments averaged 0.23 mg/g in the western basin, 1.84 mg/g in the central basin, and 0.85 mg/g in the eastern basin. The general distribution is shown in Figure 40. In the shallow western basin, with a relatively short flowthrough period, continual suspension of bottom sediments is likely, with organic nitrogen biochemically oxidized to forms readily available to aquatic life. This is substantiated by the high algal productivity of this basin. Published FWPCA data show prevailing bottom flow in


LAKE ONTARIO
LAKE HURON
LAKE ST. CLAIR
CANADA
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
BUFFALO
PORT COLBORNE
PORT MAITLAND
PORT DOVER
PORT BURWELL
PORT BRUCE
PORT STANLEY
ERIEAU
PORT CREWE
WHEATLEY
LEAMINGTON
KINGSVILLE
DETROIT
MONROE
TOLEDO
PORT CLINTON
SANDUSKY
HURON
VERMILION
LORAIN
CLEVELAND
FAIRPORT
ASHTABULA
CONNEAUT
ERIE
BARCELONA
DUNKIRK
CONTOUR INTERVAL
0.5 mg/g DRY WEIGHT
SCALE
0
10
20
30 MILES
N
0.5
1.0
1.5
2.0
2.5
3.0
79°00'
30'
80°
30'
81°
30'
82°
30'
83°
83°30'
43°00'
30'
42°
30'
41°

TOTAL PHOSPHATE (PO₄)
IN
BOTTOM SEDIMENTS
OF
LAKE ERIE
7/28-8/7/64

FIGURE 38

376-


LAKE ONTARIO
BUFFALO
79°00'
PORT COLBORNE
PORT MAITLAND
30'
DUNKIRK
BARCELONA
NEW YORK
LESS THAN 0.5 mg/g
80°
PORT DOVER
ERIE
PENNSYLVANIA
CONNEAUT
ASHTABULA
PORT BURWELL
PORT BRUCE
PORT STANLEY
81°
CANADA
FAIRPORT
CLEVELAND
OHIO
1
2
3
ERIEAU
82°
LAKE HURON
WHEATLEY
LEAMINGTON
KINGSVILLE
LAKE ST. CLAIR
MICHIGAN
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
83°
LESS THAN 0.6 mg/g
DETROIT
MONROE
TOLEDO
83°30'
43°00'
42°
41°
N
SCALE
0
10
20
30 MILES

SULFIDE IN BOTTOM SEDIMENTS OF LAKE ERIE

7/28 - 8/7/64

CONTOUR INTERVAL 1.0 mg/g DRY WEIGHT

FIGURE 39

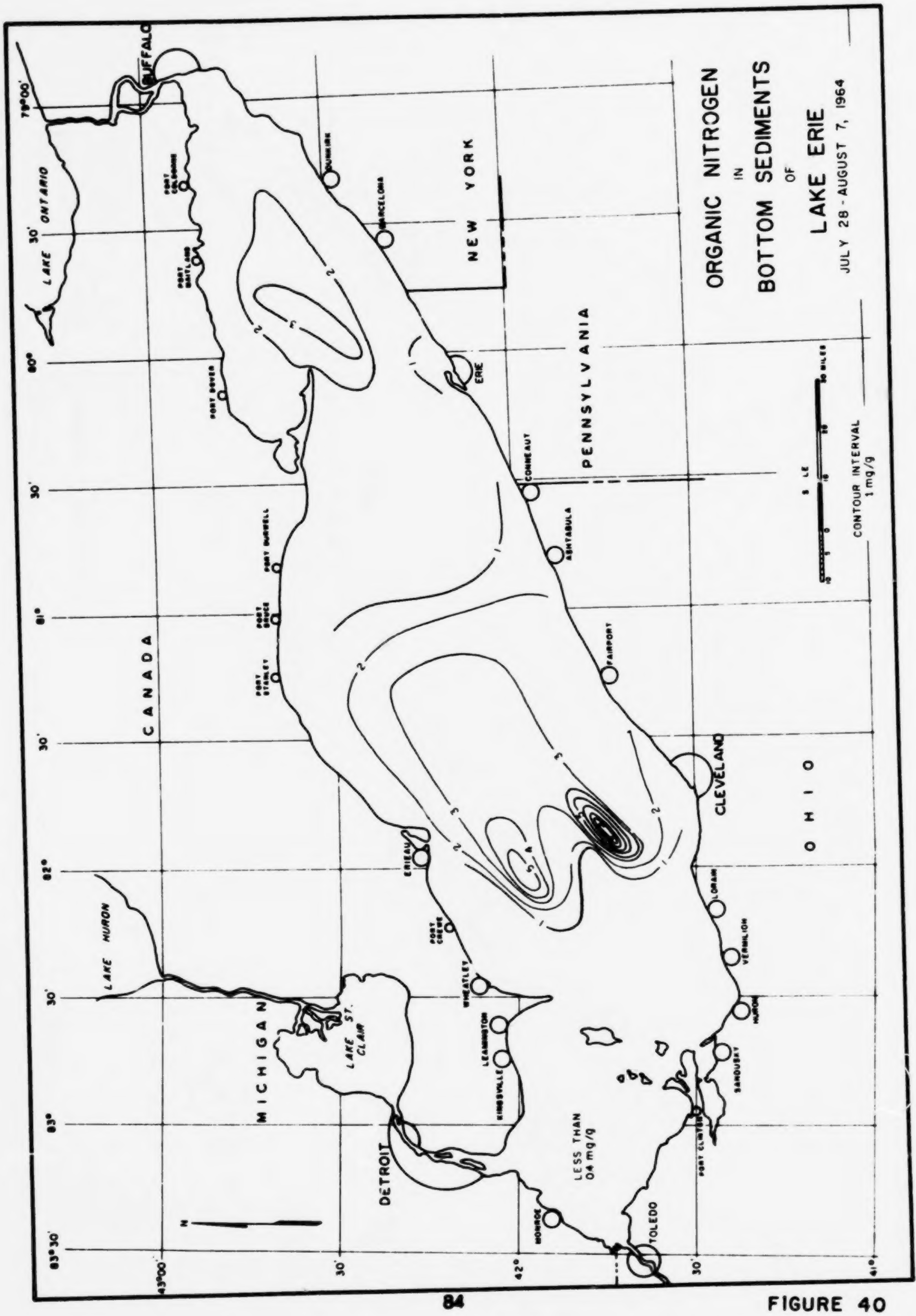

ORGANIC NITROGEN
IN
BOTTOM SEDIMENTS
OF
LAKE ERIE
JULY 28 - AUGUST 7, 1964
CONTOUR INTERVAL
1 mg/g
LESS THAN
0.4 mg/g
CANADA
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
LAKE ONTARIO
LAKE HURON
LAKE ST. CLAIR
BUFFALO
DUNKIRK
BARCELONA
ERIE
CONNEAUT
ASHTABULA
FAIRPORT
CLEVELAND
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
TOLEDO
MONROE
DETROIT
KINGSVILLE
LEAMINGTON
WHEATLEY
PORT CREWE
ERIEAU
PORT STANLEY
PORT BRUCE
PORT BURWELL
PORT DOVER
PORT MAITLAND
PORT COLBORNE
83°30'
83°
30'
82°
81°
80°
79°00'
43°00'
42°
41°
2
3
4
5
N

FIGURE 40

378<

the central basin to be extensively circulatory (Figure 35). It is indicated that a buildup of organic materials will occur as a result of the recirculation and the relatively long flowthrough period. The eastern basin with an intermediate flowthrough period, low tributary waste input and consequent low algal productivity has an average organic nitrogen concentration intermediate with respect to the other basins.

AMMONIA NITROGEN

Ammonia nitrogen, an end product in the degradation of proteinaceous materials, decreased somewhat from west to east in Lake Erie (Figure 41). The western basin sediment samples averaged 0.19 mg/g, the central basin 0.09 mg/g, and the eastern basin samples 0.07 mg/g. Ammonia is 45.2 percent of the total nitrogen in the western basin, 4.7 percent in the central, and 7.6 percent in the western. A much higher organic matter degradation rate is indicated in the western basin due to higher water temperatures.

NITRITE AND NITRATE NITROGEN

In the nitrogen cycle, organic nitrogen is gradually converted to ammonia nitrogen. Under aerobic conditions, the oxidation of ammonia to nitrites and nitrates then occurs. Lake Erie nitrate-nitrite concentrations in bottom sediments are very low since upon oxidation these forms are quickly solubilized in overlying waters. The concentration of nitrite-nitrate increased west to east in Lake Erie bottom sediments during the survey. An explanation is that sediments are less disturbed toward the east, allowing a greater opportunity for retention of these substances in the oxidation microzone through the mechanisms of adsorption. The average concentration in the samples was .001 mg/g in the western basin, .002 mg/g in the central basin, and .004 mg/g in the eastern basin.

VOLATILE SOLIDS

Volatile solids are shown as mg/g in Tables 8, 9, and 10, and the general areal pattern is shown in Figure 42. The western basin showed the highest sample average at 234 mg/g. The central basin sample average was 214 mg/g, while the eastern basin average was comparatively low at 74 mg/g. Since organic nitrogen is relatively low, and volatile solids are high, it is indicated that a large fraction of the total volatile solids in the western basin is nonprotein in character. Published FWPCA data (1968) substantiate this in work done on chlorophyll carbon and seston.

CHEMICAL OXYGEN DEMAND

The chemical oxygen demand of the bottom sediments samples averaged

TABLE 8

BOTTOM SEDIMENT CHEMISTRY - WESTERN BASIN
mg/g

Sample Location	Total Iron	Total Phosphate	Sulfide	Ammonia Nitrogen	NO_2-NO_3 Nitrogen	Organic Nitrogen	Volatile Solids	COD
1	20	.88	.01	.04	.000	.06	56	40
2	22	2.29	.34	.33	.001	.22	125	85
3	28	2.29	.05	.29	.001	.25	252	72
4	43	2.86	.56	.13	.001	.27	308	73
5	37	3.29	.36	.37	.002	.37	543	80
6	17	1.42	.12	.07	.000	.08	56	29
7	25	2.36	.27	.20	.001	.22	137	51
8	39	3.29	.40	.33	.002	.41	365	96
9	26	2.12	.21	.18	.001	.20	297	68
10	27	1.87	.21	.15	.001	.19	196	77
11	45	3.25	.04	.24	.001	.28	451	43
12	39	2.50	.06	.16	.001	.27	262	96
13	34	2.43	.32	.15	.001	.26	298	74
14	29	2.02	.27	.08	.001	.17	135	51
15	68	2.79	.25	.19	.001	.28	253	75
16	27	1.06	.21	.12	.000	.05	17	6
Avg.	33	2.29	.23	.19	.001	.23	234	63.5

TABLE 9

BOTTOM SEDIMENT CHEMISTRY - CENTRAL BASIN
mg/g

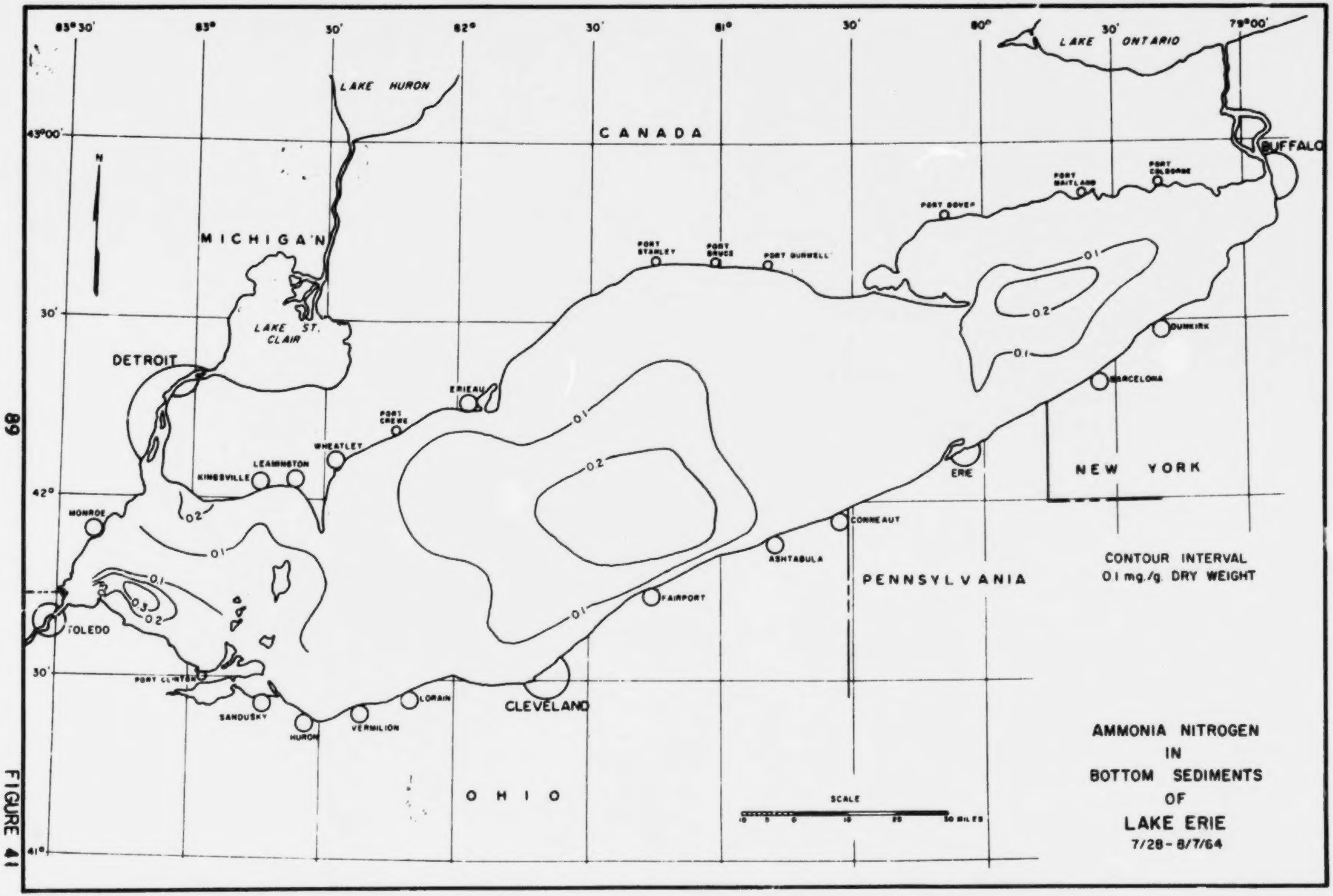
Sample Location	Total Iron	Total Phosphate	Sulfide	Ammonia Nitrogen	NO_2-NO_3 Nitrogen	Organic Nitrogen	Volatile Solids	COD
17	17	1.37	.17	.03	.000	.08	47	33
18	25	2.30	.22	.09	.000	.18	187	73
19	32	3.30	.07	.12	.001	.23	276	84
20	29	1.98	.15	.09	.002	.17	166	49
21	72	2.23	.03	.13	.001	.12	284	50
22	70	2.35	3.62	.16	.005	5.05	387	80
23	43	2.23	.01	.09	.001	.17	251	50
24	45	2.57	3.90	--	.005	9.05	357	86
25	60	1.76	2.21	.10	.008	2.86	267	71
26	22	1.09	.98	.06	.005	1.48	68	57
27	28	1.75	1.30	.09	.003	2.07	748	82
28	47	2.62	2.98	.10	.000	3.10	277	61
29	43	2.78	.13	.21	.000	3.12	326	91
30	26	1.90	.87	.05	.003	2.00	128	47
31	68	2.78	2.99	.18	.005	3.82	390	65
32	30	2.51	.05	.22	.003	2.39	174	79
33	13	1.66	.43	.03	.002	.71	42	19
34	12	1.51	.01	.00	.002	.37	22	37
35	16	0.38	.01	.00	.000	.19	12	3
36	12	0.65	.01	--	.001	.45	25	21
37	21	1.21	.15	.06	.002	1.08	67	31
Avg.	35	1.95	.97	.09	.002	1.84	214	55.7

TABLE 10

BOTTOM SEDIMENT CHEMISTRY - EASTERN BASIN
mg/g

Sample Location	Total Iron	Total Phosphate	Sulfide	Ammonia Nitrogen	NO_2-NO_3 Nitrogen	Organic Nitrogen	Volatile Solids	COD
38	1.2	1.15	.03	.02	.002	0.76	39	26
39	13	1.52	.01	.01	.002	0.02	22	1
40	38	1.56	.05	.07	.002	1.21	63	54
41	1.2	1.32	.01	.01	.005	0.41	43	13
42	.3	1.29	.04	.07	.005	0.95	58	22
43	6	1.22	.07	.19	.000	1.44	87	27
44	26	2.96	.30	.14	.000	2.08	301	59
45	18	2.66	.00	.00	.006	0.57	90	14
46	2.8	0.72	.03	.01	.000	0.33	30	9
47	1.4	0.52	.01	--	.004	--	32	14
48	28	2.61	.03	.28	.010	2.41	176	58
49	45	1.65	.01	.12	.010	--	205	43
50	.02	1.94	.01	.00	.004	--	39	13
51	34	1.95	.28	.00	.009	2.07	126	52
52	24	3.15	.01	.28	.010	1.40	201	79
53	2.1	0.42	.00	.00	.001	0.50	37	19
54	22	1.05	.01	.04	.002	0.50	24	34
55	.23	0.35	.01	.01	.004	0.13	7	8
56	14	1.86	.01	.05	.001	0.00	24	15
57	28	0.57	.09	.05	.002	0.82	40	32
58	5.6	1.21	.00	.01	.001	0.57	23	23
59	14	1.74	.01	.03	.001	0.01	23	20
60	6.8	1.38	.00	.01	.001	--	6	5
Avg.	14.4	1.51	.04	.07	.004	0.85	74	27.8

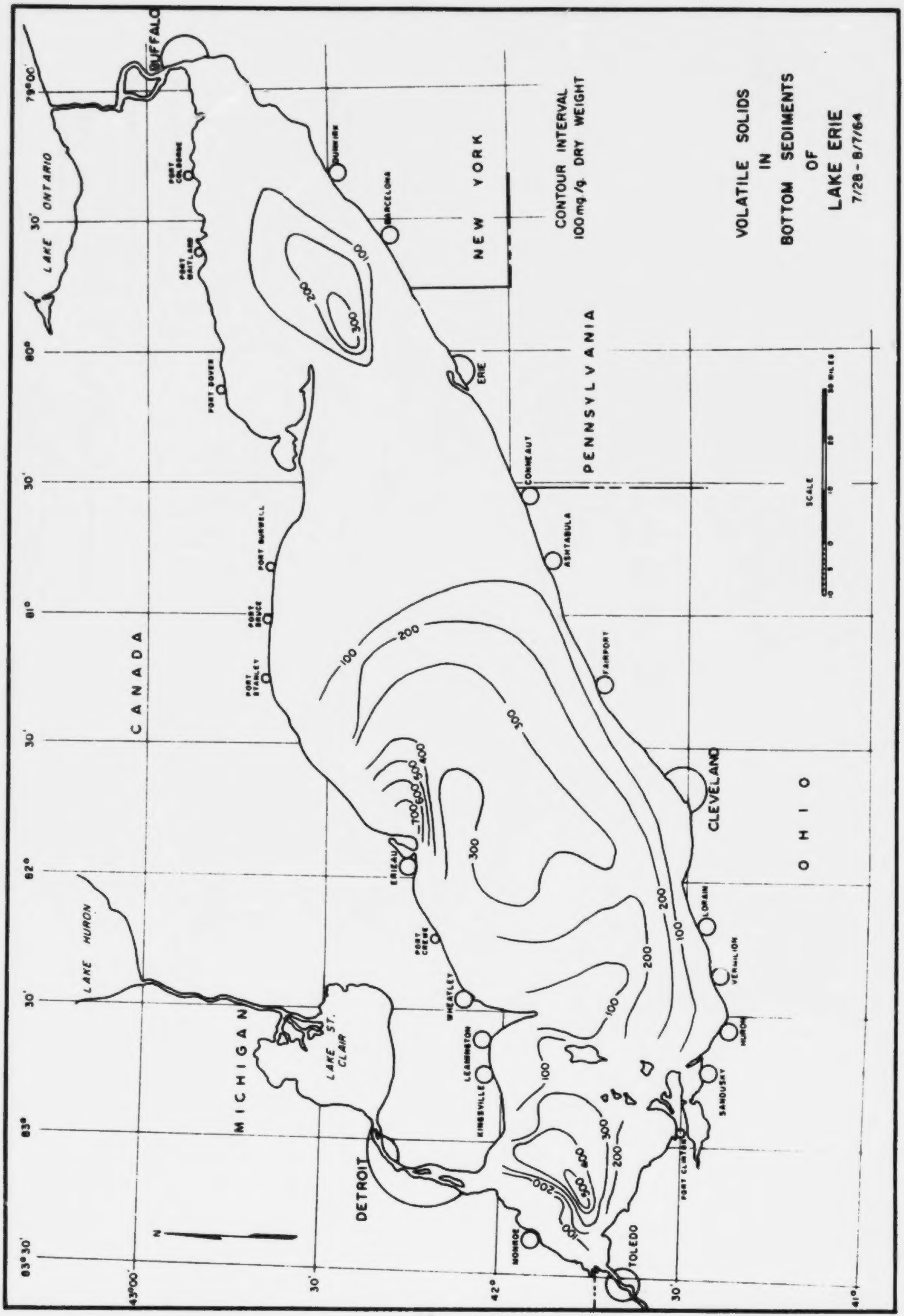
382<



AMMONIA NITROGEN
IN
BOTTOM SEDIMENTS
OF
LAKE ERIE
7/28 - 8/7/64

CONTOUR INTERVAL
0.1 mg./g. DRY WEIGHT
83°30'
83°
30'
82°
30'
81°
30'
80°
30'
79°00'
43°00'
30'
42°
30'
41°
N
LAKE HURON
LAKE ONTARIO
CANADA
MICHIGAN
LAKE ST. CLAIR
DETROIT
NEW YORK
PENNSYLVANIA
OHIO
BUFFALO
PORT COLBORNE
PORT MAITLAND
PORT DOVER
PORT BURWELL
PORT BRUCE
PORT STANLEY
ERIEAU
PORT CREWE
WHEATLEY
LEAMINGTON
KINGSVILLE
MONROE
TOLEDO
PORT CLINTON
SANDUSKY
HURON
VERMILION
LORAIN
CLEVELAND
FAIRPORT
ASHTABULA
CONNEAUT
ERIE
BARCELONA
DUNKIRK
0.1
0.2
0.3
SCALE
10 5 0 10 20 30 MILES

FIGURE 41



VOLATILE SOLIDS IN BOTTOM SEDIMENTS OF LAKE ERIE

7/28 - 8/7/64

CONTOUR INTERVAL 100mg/g. DRY WEIGHT

BUFFALO
LAKE ONTARIO
PORT COLBORNE
PORT MAITLAND
DUNKIRK
BARCELONA
NEW YORK
PENNSYLVANIA
ERIE
PORT DOVER
CONNEAUT
ASHTABULA
PORT BURWELL
PORT BRUCE
PORT STANLEY
FAIRPORT
CANADA
CLEVELAND
OHIO
ERIEAU
PORT CREWE
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
WHEATLEY
LEAMINGTON
KINGSVILLE
LAKE HURON
MICHIGAN
LAKE ST. CLAIR
DETROIT
MONROE
TOLEDO
79°00'
30'
80°
30'
81°
30'
82°
30'
83°
83°30'
43°00'
30'
42°
30'
41°
100
200
300
400
500
600
700
N
SCALE

FIGURE 42

384<

67.4 mg/g in the western basin, 58.3 mg/g in the central basin, and 29.7 mg/g in the eastern basin. This demand is due to organic matter and reduced inorganic species such as ferrous iron and sulfide sulfur. The chemical oxygen demand will vary with the oxidation-reduction potential of the sediment being analyzed. In the central basin, during summer anaerobiasis in the hypolimnion, increases in sediment COD can be expected, due to reduced oxidation-reduction potentials. Chemical oxygen demand values follow volatile solids and total iron directions in each basin.

ALPHA ACTIVITY OF BOTTOM SEDIMENTS

The maximum value was 44 pc/gram. The lowest values tend to be nearer shore, and the areas with higher activity are located in the center of the lake and toward the western end. These high values suggest accumulation following circulatory bottom flow as illustrated in Figure 35.

BETA ACTIVITY OF BOTTOM SEDIMENTS

The mean of all samples was about 38 pc/gram, and the maximum value was 100 pc/gram. Most of this activity is probably due to the long half-life, mixed-fission products of prior fallout from atmospheric detonation of nuclear weapons.

WATER CHEMISTRY

In the course of this investigation, the chemical characteristics of Lake Erie water were measured throughout the lake and at several of its harbors. In most cases the water at each station was sampled several times in both 1963 and 1964; and each time samples were taken at more than one depth, ordinarily at the surface, mid-depth, and just above the bottom. The locations of lake water sampling stations are shown in Figure 43.

For chemical study of the water, the following were measured:

1. Temperature
2. Dissolved oxygen (DO)
3. Chemical oxygen demand (COD)
4. Biochemical oxygen demand (BOD)
5. Conductivity (μmhos at 25°C)
6. Dissolved solids (DS)
7. Total solids (TS)
8. Total alkalinity (as $CaCO_3$)
9. Hydrogen-ion concentration (pH)
10. Chlorides
11. Sulfate (SO_4)
12. Calcium (Ca)

13. Magnesium (Mg)
14. Sodium (Na)
15. Silica (SiO_2)
16. Soluble phosphate (PO_4)
17. Total Nitrogen (N)
18. Ammonia Nitrogen (NH_3-N)
19. Organic Nitrogen (Org-N)
20. Nitrate Nitrogen (NO_3-N)
21. Alkylbenzene sulfonate (ABS)
22. Phenols
23. Toxic metals (zinc, copper, cadmium, nickel, lead, chromium)

Figure 44 depicts graphically the concentrations of major constituents in each of the lake's basins along with input concentrations from the upper lakes.

TEMPERATURE

The water temperature at all sampling stations and at all sample depths was measured with a laboratory thermometer. Also bathythermograph measurements were made at nearly all stations.

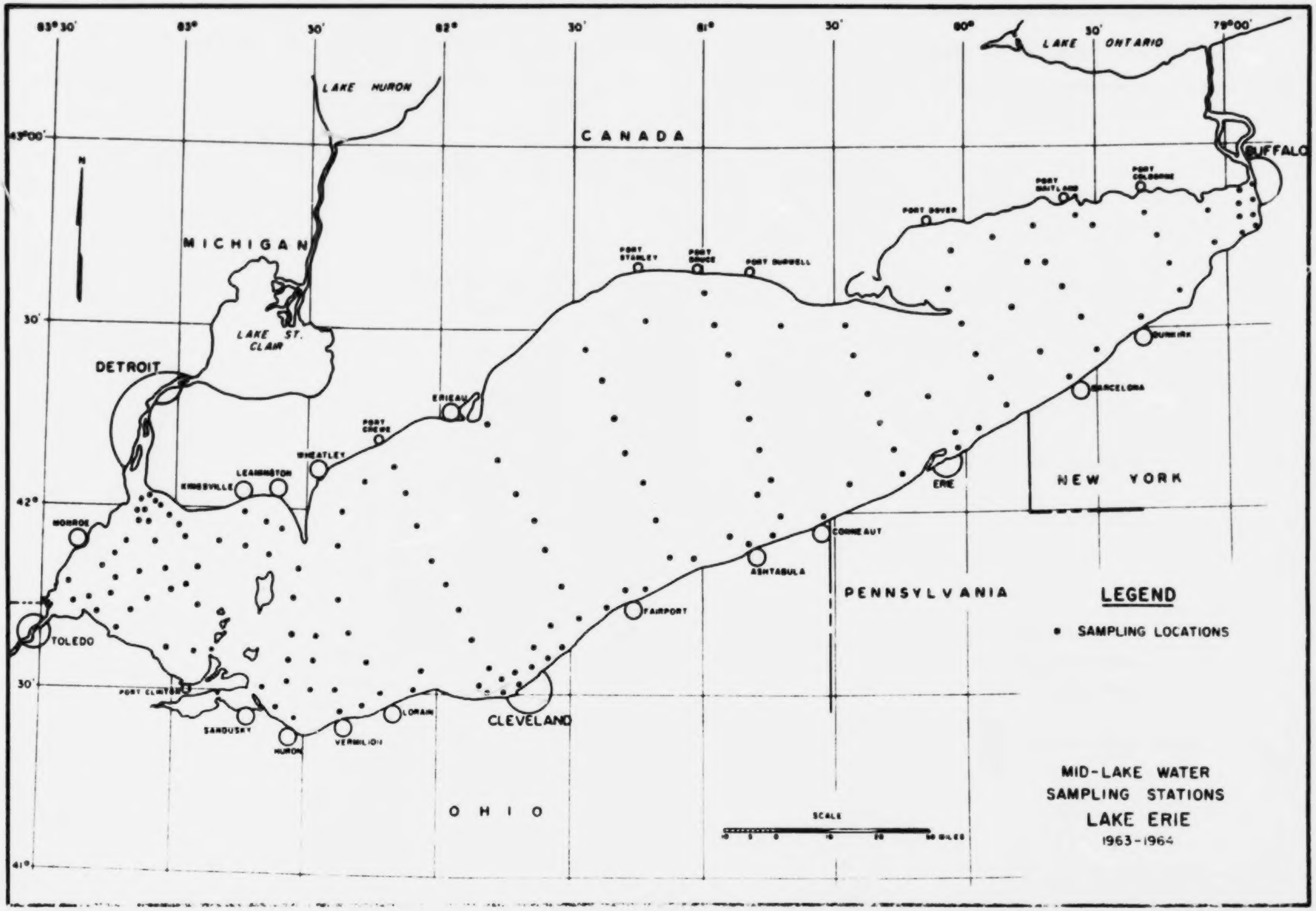
Excessive water temperatures were not encountered at any place in Lake Erie proper during the surveys. Temperatures were, of course, significant in the calculation of percent saturation of oxygen and in the determination of the extent of thermal stratification.

Lake Erie temperatures, as reported, are of no direct significance with regard to water quality. Indirectly, by limiting oxygen dissolution and increasing chemical and biological reaction rates, high temperatures can be important.

DISSOLVED OXYGEN

Dissolved oxygen in Lake Erie, as in all natural waters, is of prime importance in maintaining water quality. It is essential for reduction, purification, and stabilization of wastes. It is also metabolically essential to all types of aquatic life. Adverse effects of high oxygen content are known only in some industrial uses, tending to accelerate corrosion of equipment.

Dissolved oxygen is supplied to pure waters by natural, physical aeration, or absorption from the atmosphere. Oxygen is poorly soluble in water, and since it does not react chemically with water its solubility is directly proportional to its partial pressure. As a result, Boyle's Law may be used to calculate the amounts present at saturation at any given temperature.


83°30'
83°
30'
82°
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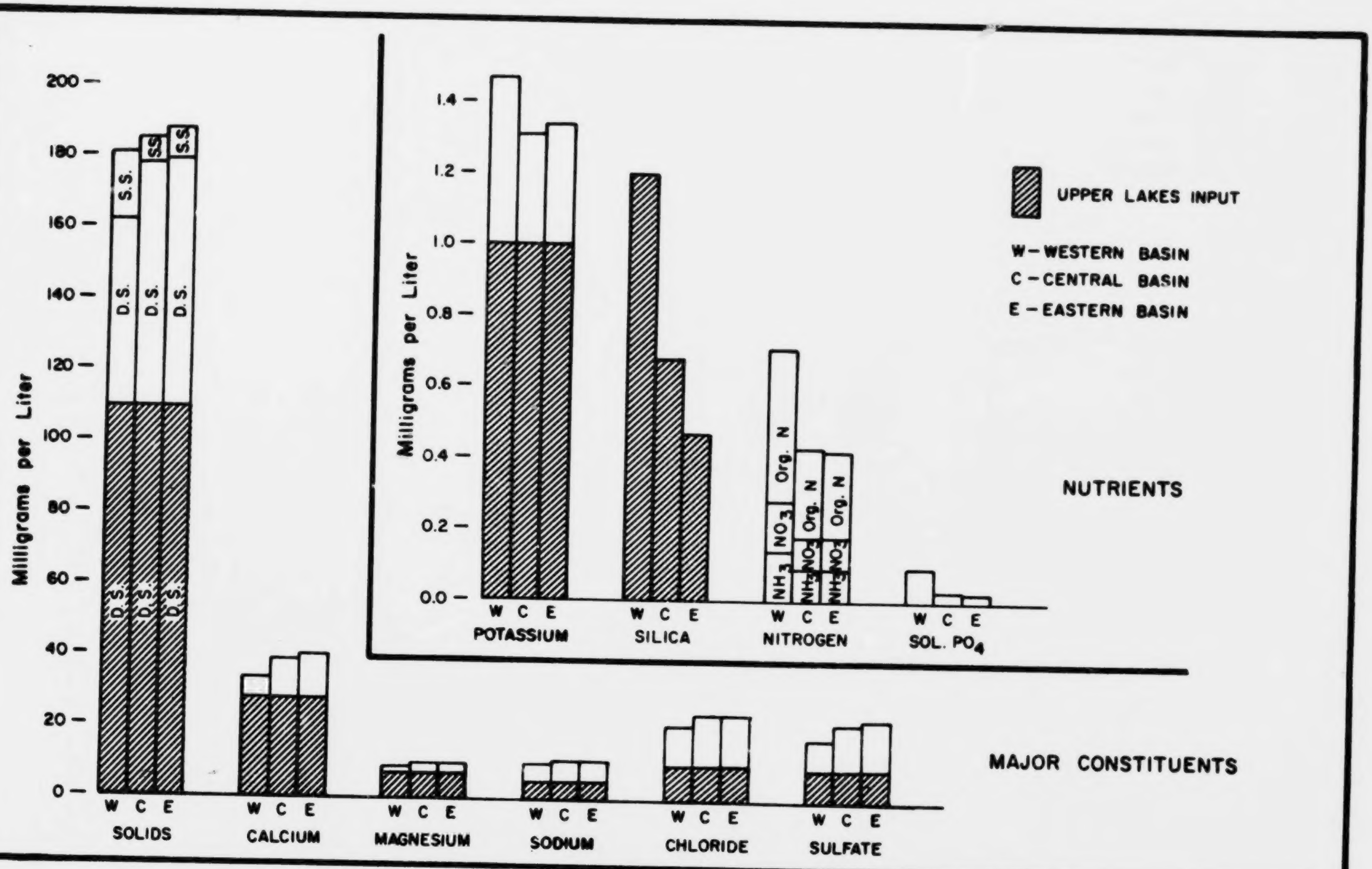
81°
30'
80°
30'
79°00'
43°00'
30'
42°
30'
41°
LAKE HURON
LAKE ONTARIO
CANADA
MICHIGAN
LAKE ST. CLAIR
DETROIT
N
PORT STANLEY
PORT BRUCE
PORT BURWELL
PORT DOVER
PORT MAITLAND
PORT COLBORNE
BUFFALO
DUNKIRK
BARCELONA
NEW YORK
ERIE
ERIEAU
PORT CREWE
WHEATLEY
LEAMINGTON
KINGSVILLE
MONROE
TOLEDO
PORT CLINTON
SANDUSKY
HURON
VERMILION
LORAIN
CLEVELAND
FAIRPORT
ASHTABULA
CONNEAUT
PENNSYLVANIA
OHIO
LEGEND
• SAMPLING LOCATIONS
MID-LAKE WATER
SAMPLING STATIONS
LAKE ERIE
1963-1964
SCALE
10 5 0 10 20 30 MILES

FIGURE 43

FIGURE 44



CHEMISTRY OF LAKE ERIE WATER IN WESTERN, CENTRAL AND EASTERN BASINS

Water in the pure state can become temporarily supersaturated with oxygen with a sharp increase in temperature. Ordinarily, however, in Lake Erie, supersaturation results from the photosynthetic process of aquatic plant life. During the daylight hours green algae, utilizing energy from the sun, produce carbohydrates from carbon dioxide and water. In the process copious amounts of oxygen are released to the surrounding water. At night, however, aquatic plant life consumes oxygen through normal respiration. During heavy algal blooms the oxygen may increase to 150 percent of saturation or more, while at night it may decrease to less than 100 percent.

Organic wastes, either natural or synthetic, will decrease the oxygen content of receiving waters. Biochemical oxidation of wastes proceeds at an increased rate with an increase in temperature. The biochemical need for oxygen becomes greater as the oxygen resources become less due to decreased oxygen dissolution with increased temperatures. Most fish also have a need for more oxygen as temperatures rise. A compensating factor is that planktonic oxygen production is increased as temperatures rise, if incident light levels are constant. This can lead to large vertical differences in oxygen content in waters in the same area.

The waters of Lake Erie are normally saturated or nearly saturated with oxygen during the months of October through April and mixing is prevalent from top to bottom. Exceptions may occur only in the immediate vicinity of lakeshore waste outfalls and the mouths of tributaries.

Beginning usually in late May the oxygen content begins to vary in Lake Erie both areally and vertically. Harbors show oxygen deficiencies and a slight reduction occurs in bottom waters of the lake. During the months of May and June oxygen depletions in the central and eastern basins are not serious and 80 percent or more of saturation is common. During these months in the western basin, temporary thermal stratification may occur during prolonged quiescent periods (Carr, Applegate, and Keller, 1964). If the thermocline is near the bottom, oxygen below it may be exhausted for short periods due to the low dissolved oxygen potential of the thin hypolimnion. Reoxygenation occurs when wind turbulence is sufficient to destroy the thermocline.

Stratification in the central basin may occur during the same periods in May and June but the thermocline is shallow and the oxygen content below it is high. Only slight depletion may occur. Saturation values remain essentially constant in the eastern basin during this time.

In June stable stratification is established in the central basin and in the eastern basin. The stratification, except for increasing warmth of the epilimnion waters, stays approximately the same until the lake begins to cool in August. The epilimnion waters normally are from 90 to 100 percent of saturation. Hypolimnion water, that part below the thermocline, decreases in oxygen content throughout the summer. It may reach zero in the central basin where the hypolimnion is thin. It may decline to 60 or 70 percent of saturation in the eastern basin below the thermocline. Low dissolved oxygen was first observed in the central basin in 1929 (Fish, 1955). Since then it has occurred more frequently and for longer periods.

In the western basin in mid-summer, dissolved oxygen in the surface waters is maintained at or above 100 percent saturation while bottom waters are somewhat lower, generally between 50 and 75 percent. However, intermittent stratification occurs throughout the summer with proper weather conditions. As previously described, oxygen may be completely exhausted locally in bottom waters at these times. In addition, the bottom waters have high temperatures, oxidation of organic sediments can be rapid, and oxygen depletion is quickly accomplished. Carr, Applegate, and Keller (1964) report that it now takes only five days of meteorological and consequent hydrological quiescence to result in oxygen exhaustion, whereas in 1953 it required 28 days.

The lake begins to cool in August. Stratification occurs less frequently or not at all in the western basin from that time on. However, in the central basin depletion becomes more severe since the thermocline moves downward, the hypolimnion becomes thinner, and the oxygen contained therein is biologically assimilated.

Oxygen depletion of significance occurs in nearshore waters only in harbor areas and tributary mouths which are receptacles for large volumes of wastes. The most severe conditions occur in Cleveland Harbor and locally in Erie and Buffalo Harbors. Others with less severe but still serious problems are the mouths of the Detroit, Raisin, and Maumee Rivers. Conditions in these areas are more severe upstream away from lake dilution.

CHEMICAL OXYGEN DEMAND

The chemical oxygen demand (COD) has been determined on several hundred water samples taken throughout Lake Erie. Determinations were made employing the potassium dichromate method. Although it gives the order of magnitude of the ultimate biochemical oxygen demand (BOD), it is not a substitute for that determination. Indications of the rate of natural oxidation are not provided and differentiation between biologically oxidizable, and biologically inert organic matter is not discernible.

The COD of Lake Erie water samples is important in that it provides an indication of degree of pollution and provides a basis for areal comparison. COD results of the lake samples do not indicate adverse water quality conditions. Extreme and average COD for samples from each of the basins are shown in Table 11.

The COD of western basin water during the summers of 1963 and 1964, averaged 10.4 mg/l with extremes of 6.5 and 28.0 mg/l. Highest values were in the western one-third of the basin with a general decrease eastward. In the central basin the average was 7.1 mg/l with extremes of 3.1 and 16.0 mg/l. The eastern basin ranged between 6.1 and 27.0 with an average of 7.4 or approximately the same as the central basin. The highest values were near the south shore.

In harbor waters the highest COD of 53 mg/l was found near the mouth of the Maumee River. High values were also found in Sandusky Bay and Erie Harbor.

BIOCHEMICAL OXYGEN DEMAND

Determinations of 5-day biochemical oxygen demand (BOD_5) were not made on mid-lake samples except for a few on one cruise (66) in August 1964. However, numerous determinations were made in the nearshore zone along the south shore. Samples were taken only during the summer months in 1964, between May and September. BOD analyses were made on Detroit River samples by the FWPCA Detroit River Project.

Highest BOD_5 values were found in Sandusky Bay, averaging 3.8 mg/l; Erie Harbor, averaging 3.3 mg/l; and in Ashtabula Harbor, averaging 3.2 mg/l. Lorain and Cleveland harbors averaged about one-half these values. BOD_5 values at the mouth of the Detroit River ranged from 2 to 5 mg/l.

BOD_5 values decrease rapidly with distance from shore. The Bureau of Commercial Fisheries reports that central basin hypolimnion water averages about 1 mg/l BOD_5. A maximum of 1.5 mg/l was found by the FWPCA in the hypolimnion in August 1964.

The BOD_5 values indicate that outside the nearshore areas (widest along the Michigan shore and the Maumee Bay area) the water of Lake Erie is of high quality in this respect.

CONDUCTIVITY AND DISSOLVED SOLIDS

A good general indicator of the chemical water quality of Lake Erie is the dissolved solids content which is the content of dissolved elements and compounds. Conductivity, or the capacity of the water to conduct an electrical current, is directly related to the dissolved solids content or the ionic concentration. In offshore waters, several hundred measurements have shown that conductivity in micromhos/cm at 25°C divided by 1.66 equals the dissolved solids content in milligrams/liter. This relation does not necessarily hold in nearshore and harbor

TABLE 11

C.O.D. CONCENTRATIONS IN LAKE ERIE
mg/l

		Western Basin			Central Basin			Eastern Basin		
Cruise	Date	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	--	--	--	--	--	--
40	5/63	--	--	--	--	--	--	--	--	--
42	6/63	--	--	--	--	--	--	--	--	--
52	10/63	10.6	3.5	6.5	8.6	3.1	6.4	20.9	4.7	6.9
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	13.1	7.5	10.7	--	--	--	--	--	--
58	5/64	--	--	--	16.0	3.6	8.4	27.0	5.7	8.8
61	6/64	28.0	4.2	12.3	--	--	--	--	--	--
62	6/64	--	--	--	6.0	5.0	5.5	7.0	6.0	6.1
66	8/64	--	--	--	9.0	7.0	8.1	13.0	6.0	8.0
67	9/64	29.0	1.1	12.0	--	--	--	--	--	--
Avg.				10.37			7.10			7.45

Michigan waters of Lake Erie not included.

areas where the content of one or more salts may be excessive.

Table 12 and 13 list the conductivity values and dissolved solids concentrations for the three basins as maxiumums, minimums, and averages for each of the mid-lake cruises in 1963 and 1964. Important is the fact that the average concentration of dissolved solids in the central and eastern basins is virtually identical at 180 mg/l, while the average concentration in the western basin is about 18 mg/l lower. However, the range of values is greatest in the western basin and decreases eastward, indicating an increasing tendency toward uniformity to the east. Conductivity values show the same pattern.

The lowest dissolved solids concentration found during the sampling of Lake Erie was 110 mg/l at the mouth of the Detroit River in the mid-channel flow. This value is near that for the average concentration in Lake Huron as reported by Beeton (1965). In the eastern basin the value is 179 mg/l; therefore, a net increase of 69 mg/l occurs in Lake Erie. However, 75 percent of that increase occurs in the western basin indicating the comparative severity of chemical loading from sources near the west end of the lake (Figure 44).

Dissolved solids content has been increasing in Lake Erie at a fairly rapid rate since the turn of the century (Figure 45). Dissolved solids content along the shore is generally higher and at some places is now excessive. Of particular concern are the concentrations in Sandusky Bay with values up to 700 mg/l, and the bottom waters in Fairport Harbor with values of more than 3,000 mg/l. Sulfates and chlorides account for most of these higher values.

Dissolved solids cannot be expected to decrease in the future. In fact the rate of increase may be expected to rise with increased population and activity around the lake unless discharges are rigidly controlled.

TOTAL SOLIDS

Total solids are the evaporation residue from unfiltered samples. Suspended solids, those not in solution, are equal to the total solids less the dissolved solids.

In central and eastern basin mid-lake, the total solids are nearly equal in concentration with average values of 185 and 188 mg/l, respectively (see Table 14 and Figure 44). Western basin water is also approximately equal at 181 mg/l.

Suspended solids average less than 10 mg/l in the central and eastern basins. Western basin values are double this amount, and during the survey period reached a maximum of about 50 mg/l. This may further

TABLE 12

CONDUCTIVITY IN LAKE ERIE
umhos/cm
at 25°C

Cruise	Date	Western Basin			Central Basin			Eastern Basin		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	--	--	--	--	--	--
40	5/63	300	262	286	328	260	291	296	275	289
42	6/63	--	--	--	353	312	324	328	314	319
52	10/63	304	216	259	330	254	290	320	284	292
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	334	220	268	--	--	--	--	--	--
58	5/64	--	--	--	330	276	289	--	--	--
61	6/64	364	222	286	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	344	284	305	324	296	305
67	9/64	310	196	263	--	--	--	--	--	--
Avg.				272			300			301

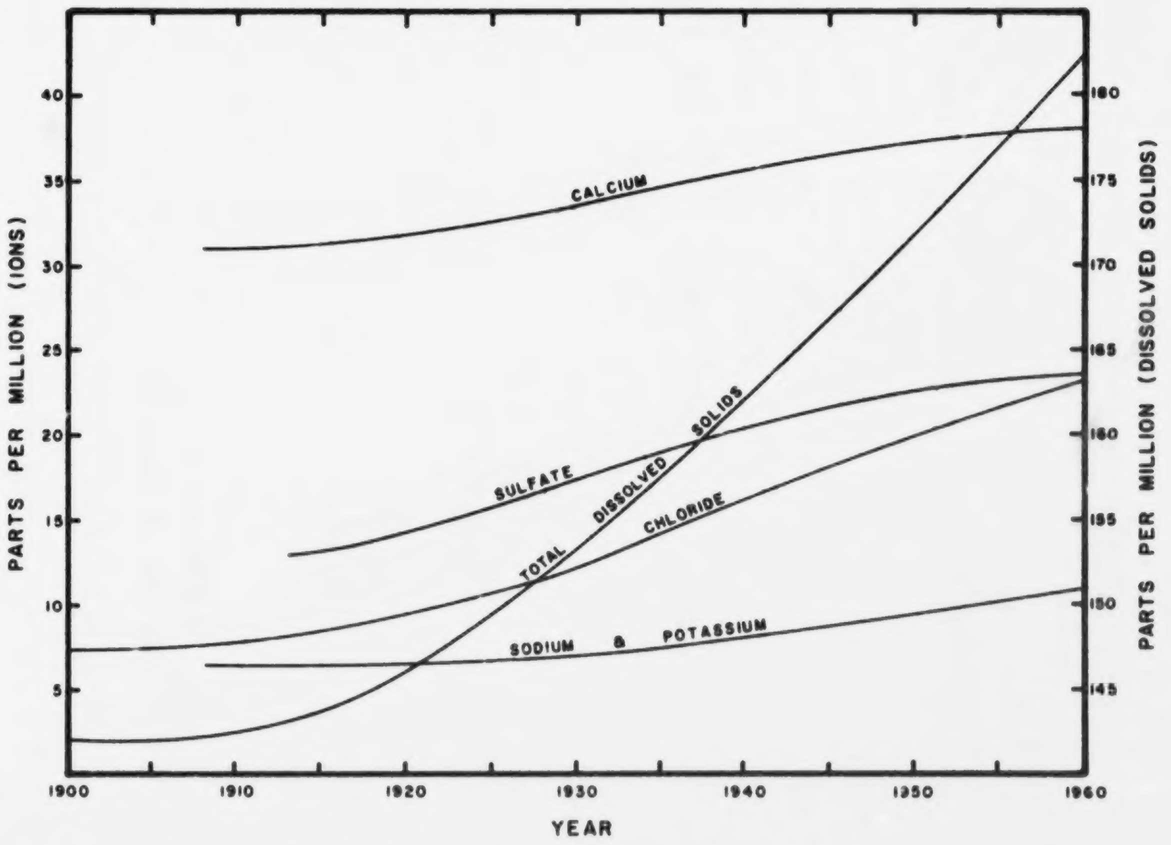
Michigan waters of Lake Erie not included.

TABLE 13

DISSOLVED SOLIDS CONCENTRATIONS IN LAKE ERIE
mg/l

		Western Basin			Central Basin			Eastern Basin		
Cruise	Date	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	180	155	170	190	160	182
40	5/63	186	172	177	239	190	204	233	183	205
42	6/63	--	--	--	--	--	--	--	--	--
52	10/63	198	135	156	209	137	175	205	161	184
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	200	120	152	--	--	--	--	--	--
58	5/64	--	--	--	180	160	177	190	160	175
61	6/64	220	120	170	--	--	--	--	--	--
62	6/64	--	--	--	190	140	170	160	150	158
66	8/64	--	--	--	180	170	171	190	160	172
67	9/64	190	110	153	--	--	--	--	--	--
Avg.				162			178			179

Michigan waters of Lake Erie not included.



CHANGES IN CHEMICAL CHARACTERISTICS OF LAKE ERIE

(ADAPTED FROM BEETON, 1965)

FIGURE 45

TABLE 14

TOTAL SOLIDS CONCENTRATIONS IN LAKE ERIE
mg/l

		Western Basin			Central Basin			Eastern Basin		
Cruise	Date	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	--	--	--	--	--	--
40	5/63	--	--	--	--	--	--	--	--	--
42	6/63	--	--	--	--	--	--	--	--	--
52	10/63	196	147	166	218	159	186	222	167	193
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	250	150	187	--	--	--	--	--	--
58	5/64	--	--	--	200	190	192	200	190	192
61	6/64	250	150	188	--	--	--	--	--	--
62	6/64	--	--	--	200	175	191	200	180	191
66	8/64	--	--	--	180	170	171	240	170	178
67	9/64	230	140	181	--	--	--	--	--	--
Avg.				181			185			188

Michigan waters of Lake Erie not included.

increase during storms and periods of heavy runoff.

The minimum total solids concentration was found at the mouth of the Detroit River in the mid-channel flow with a value of 140 mg/l. This is 48 mg/l less than the average for the eastern basin, providing a comparison of Detroit River inflow and Niagara River outflow.

CHLORIDES

Chlorides are among the most stable of the dissolved substances, unaffected by chemical, biochemical, or physical reaction. Although they are generally found in acceptably low concentrations, they are very important in tracing sources of significant municipal and industrial pollution. Chloride monitoring is useful in establishing long-term trends in general water quality. Chlorides have increased threefold (Beeton, 1964) in Lake Erie since 1900 (Figure 45).

Maximum, minimum, and average values for mid-lake waters on each cruise are shown in Table 15. During the survey period the chlorides in the western basin away from nearshore areas averaged 21.3 mg/l. In the central basin the average was 24.5 mg/l and in the eastern basin 24.4 mg/l. The lowest value recorded was 10 mg/l at the mouth of the Detroit River in the mid-channel flow. If this is used as a base, or inflow concentration, then 11.3 mg/l are gained in the western basin and 3.2 in the central and eastern basins. Thus 77 percent of the gain is derived from inputs to the western basin (see Figure 44).

In nearshore waters chloride values are higher (Table 29). Along the west side of the Detroit River and along the Michigan shore, values of more than 40 mg/l are common. It is from this area of the basin that most chlorides originate. Maumee Bay, Sandusky Bay, and Lorain Harbor do not show concentrations much above the average lake values. Cleveland Harbor averages 35 mg/l and ranges up to about 90 mg/l. Ashtabula and Erie Harbors both average more than 30 mg/l. By far the highest values have been found in Fairport Harbor, with concentrations up to 350 mg/l in the upper water and up to ten times this amount in the bottom waters. Chloride concentrations are so high that they create a permanent density stratification in and around Fairport Harbor. High concentrations and subsequent stratification dissipate to background lake values within a few miles.

SULFATES

Sulfates, like chlorides, are among the more persistent of dissolved compounds and are generally found in acceptably low concentrations. They can be useful as tracers for pollution sources if natural background levels are known. They are also important in establishing long-term trends in water quality. They have increased in concentration by 90 percent in Lake Erie since 1910 (Figure 45) but now appear to be leveling off.

TABLE 15

CHLORIDE CONCENTRATIONS IN LAKE ERIE
mg/l

Cruise	Date	Western Basin			Central Basin			Eastern Basin		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	31	21	24	25	22	23
40	5/63	22	16	19	33	20	24	28	21	24
42	6/63	--	--	--	--	--	--	--	--	--
52	10/63	29	10	18	31	19	22	25	21	22
55	4/64	34	15	21	46	23	24	31	22	24
57	5/64	32	12	22	--	--	--	--	--	--
58	5/64	--	--	--	28	26	27	27	27	27
61	6/64	31	13	25	--	--	--	--	--	--
62	6/64	--	--	--	26	25	26	28	24	26
66	8/64	--	--	--	--	--	--	29	23	25
67	9/64	32	11	23	--	--	--	--	--	--
Avg.				21.3			24.5			24.5

Michigan waters of Lake Erie not included.

Table 16 lists maximum, minimum, and average concentrations in each basin for each sampling cruise. In the western basin for the periods of the surveys in 1963 and 1964, sulfates ranged from 9 to 35 mg/l in open waters with an average of 17.7 mg/l. In the central basin the range was 15 to 43 mg/l with an average of 22.4 mg/l. The range in the eastern basin water was 17 to 33 mg/l with an average of 23.4 mg/l. Using the value of 9 mg/l as the concentration derived from upper lakes inflow, there is a gain in Lake Erie of 14.4 mg/l. Inputs to the western basin account for 60 percent of that gain, with 40 percent from central and eastern basin sources (Figure 44).

In the nearshore zone significant concentrations have been found in Sandusky Bay with an average of 127.1 mg/l. Lorain and Erie Harbors did not show high concentrations. Sulfate levels at other harbors were low, but upstream data indicate that the Cuyahoga and Grand Rivers supply significant amounts. Obviously large quantities must be derived from the Detroit-Monroe-Toledo area. Concentrations at the Monroe, Michigan water intake are normally more than twice the average in the western basin.

CALCIUM

Hardness is caused by divalent metallic ions that are capable of reacting with soap to form precipitates and with certain anions in the water to form scale. Calcium is the principal cation associated with this effect, and as such, knowledge of its concentration is necessary for the production of satisfactory water for domestic and industrial uses.

Calcium, in its concentration pattern, is similar to sulfates in Lake Erie (Table 17 and Figure 44). Its average concentration in the western basin water is 33.9 mg/l with a maximum of 43 mg/l and a minimum of 28 mg/l. In the central basin it ranges between 32 and 49 mg/l with an average of 39.5 mg/l, while in the eastern basin it averages 40.5 mg/l and ranges between 36 and 49 mg/l.

If the value of 28 mg/l is near that originating in the upper lakes, then calcium is not appreciably accumulating in Lake Erie. Compared to most other constituents, the accumulation from western basin sources is rather low, being only 47 percent of the total accumulating in Lake Erie exclusive of upper lakes input. An additional 45 percent accumulates from additions to the central basin, while the remaining 8 percent accumulates from eastern basin additions. Large quantities of calcium have been found in Sandusky Bay, averaging 65 mg/l and ranging up to 114 mg/l.

Calcium concentrations have increased only a small amount in Lake Erie during the past 30 years (Figure 45). Calcium will react with

400<

TABLE 16

SULFATE CONCENTRATIONS IN LAKE ERIE
mg/1

Cruise	Date	Western Basin			Central Basin			Eastern Basin		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	28	22	24.2	29	20	24.1
40	5/63	21	11	17.7	43	21	24.8	25	22	23.7
42	6/63	25	18	21.2	31	18	23.5	26	23	24.3
52	10/63	23	14	17.7	25	15	21.0	33	18	26.4
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	35	11	17.1	--	--	--	--	--	--
58	5/64	--	--	--	25	20	21.3	23	17	20.1
61	6/64	30	9	16.6	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	22	18	19.8	26	18	21.8
67	9/64	28	9	16.2	--	--	--	--	--	--
Avg.				17.7			22.4			23.4

Michigan waters of Lake Erie not included.

TABLE 17

CALCIUM CONCENTRATIONS IN LAKE ERIE
mg/l

Cruise	Date	Western Basin Max.	Western Basin Min.	Western Basin Avg.	Central Basin Max.	Central Basin Min.	Central Basin Avg.	Eastern Basin Max.	Eastern Basin Min.	Eastern Basin Avg.
9	4/63	--	--	--	38	37	37.3	40	36	38.5
40	5/63	37	28	32.4	44	34	37.4	39	36	37.9
42	6/63	37	32	34.5	39	34	36.8	40	36	38.0
52	10/63	34	29	32.2	49	32	40.2	44	40	41.4
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	43	31	36.1	--	--	--	--	--	--
58	5/64	--	--	--	47	46	46.5	49	47	47.6
61	6/64	42	29	35.4	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	41	38	38.9	42	38	39.9
67	9/64	37	28	33.3	--	--	--	--	--	--
Avg.				33.9			39.5			40.5

Michigan waters of Lake Erie not included.

phosphates, sulfates, and carbonates at prevailing Lake Erie hydrogen ion concentrations (above pH 8.0) to form insoluble precipitates, thus creating a stabilizing calcium effect.

Calcium in Lake Erie presents no known health hazard. In addition it may be important in moderating phosphate concentrations by precipitating them from solution.

MAGNESIUM

Magnesium also is considered as hardness but in Lake Erie is one of the more insignificant constituents. Its content averages 8.7 mg/l in the western basin, 10.0 mg/l in the central basin, and 10.0 mg/l in the eastern basin (Table 18 and Figure 44).

If the minimum of 7 mg/l found at the mouth of the Detroit River in the mid-channel flow is taken as the concentration of the upper lakes input, then only 3 mg/l are added to Lake Erie from basin sources. Fifty-seven percent of this amount is added from western basin sources. Comparatively large concentrations, averaging 22 mg/l, have been found in Sandusky Bay.

Magnesium concentrations are not expected to increase significantly in Lake Erie.

SODIUM

Sodium has little sanitary significance in Lake Erie. It is an indicator of relative quantities of salt being discharged to the lake and thus an indicator to trends in chemical water quality. However, sodium does have public health significance. In cases of cardiovascular deficiency, it is imperative that sodium intake be kept at a minimum. Waste sources to Lake Erie are from brine discharges. Maximum, minimum, and average concentrations for each basin are shown in Table 19.

Sodium concentrations in the western basin water averages 9.9 mg/l and ranges between 4.7 and 19 mg/l. In the central basin the average concentration increases to 11.0 mg/l, ranging between 8.3 and 17 mg/l. The eastern basin is essentially the same as the central basin with an average of 10.9 mg/l and a range of 9.3 to 15 mg/l.

The low of 4.7 mg/l is near the average for the discharge concentration from the upper lakes. This concentration more than doubles within Lake Erie, and 83 percent of this increase results from discharges to the western basin (Figure 44).

POTASSIUM

Potassium, like sodium, has no great sanitary significance in the

TABLE 18

MAGNESIUM CONCENTRATIONS IN LAKE ERIE
mg/l

Cruise	Date	Western Basin			Central Basin			Eastern Basin		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	11	10	10.2	11	10	10.1
40	5/63	10	9	9.3	10	10	10.0	11	10	10.1
42	6/63	9	8	8.7	9	7	8.2	9	7	8.4
52	10/63	9	8	8.1	10	8	8.9	10	8	9.0
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	11	7	8.5	--	--	--	--	--	--
58	5/64	--	--	--	14	13	13.3	14	12	12.8
61	6/64	11	8	9.3	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	11	9	9.7	11	8	9.6
67	9/64	11	7	8.4	--	--	--	--	--	--
Avg.				8.7			10.0			10.0

Michigan waters of Lake Erie not included.

TABLE 19

SODIUM CONCENTRATIONS IN LAKE ERIE
mg/l

		Western Basin			Central Basin			Eastern Basin		
Cruise	Date	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	12.0	8.9	9.75	9.9	9.4	9.51
40	5/63	9.0	6.8	7.78	12.3	8.3	9.65	10.5	8.6	9.30
42	6/63	11.2	8.5	9.80	14.7	9.0	10.20	12.7	9.5	10.62
52	10/63	13.0	4.7	8.47	13.0	9.5	10.80	15.0	10.0	11.18
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	17.0	6.4	10.91	--	--	--	--	--	--
58	5/64	--	--	--	17.0	13.0	14.50	14.0	12.0	12.83
61	6/64	17.0	5.5	11.24	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	13.0	11.0	11.43	13.0	11.0	11.72
67	9/64	19.0	5.7	11.27	--	--	--	--	--	--
Avg.				9.91			11.05			10.86

Michigan waters of Lake Erie not included.

Great Lakes. In most natural waters it is reported as a part of "sodium-plus-potassium" because of low concentrations and analytical complexities. Peculiarly, as concentrations of both these elements increase in natural waters, the proportion of sodium to potassium increases. In Lake Erie the ratio of sodium to potassium is about 8 to 1. Sodium plus potassium has approximately doubled in concentration in Lake Erie since 1920 (Figure 45).

Potassium is an essential nutrient for aquatic life and can be limiting in natural waters.

The potassium concentrations found in each of the basins are shown in Table 20 and Figure 44. The concentration of potassium in the western basin water averages 1.47 mg/l and varies from 1.0 to 4.5 mg/l. In the central basin it averages 1.31 mg/l and ranges from 1.1 to 1.6 mg/l, while in the eastern basin the average is about the same at 1.34 mg/l and the range is 1.1 to 1.9 mg/l.

Placing the Detroit River mid-channel input concentration at 1.0 mg/l, there is a 47 percent gain in the western basin and then an 11 percent drop between the western and central basins. The drop may represent uptake by aquatic life or dilution by lower-level potassium waters.

Sandusky Bay averaged 2.6 mg/l and ranged up to 4 mg/l, indicating it as an important source of potassium. The Michigan shore waters, with concentrations above 4 mg/l, indicated large sources in that area. Cleveland Harbor concentrations were similar. Other sources along the United States shore do not appear to be significant.

SILICA

Dissolved silica (SiO_2) in Lake Erie is one of the few constituents which shows lower concentrations, on the average, than the upper lakes. Presumably, this is due to uptake and precipitation by aquatic organisms, principally diatoms. Silica in natural waters has no known health significance. It has some significance in industrial use, especially in high pressure boiler feed water.

In the western basin the water averages 1.20 mg/l silica and ranges from 0.3 to 5.0 mg/l (Table 21 and Figure 44). In the central basin the average decreases to 0.68 mg/l, ranging from 0.2 to 3.5 mg/l. The eastern basin water averages 0.47 mg/l and ranges from 0.2 to 3.5 mg/l.

All tributaries contribute silica, since silica is a universal mineral. The most important sources are soil and land runoff, and mineral refining industries.

Silica will not significantly increase the dissolved solids content of Lake Erie.

TABLE 20

POTASSIUM CONCENTRATIONS IN LAKE ERIE
mg/1

Cruise	Date	Western Basin			Central Basin			Eastern Basin		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	1.4	1.1	1.18	1.4	1.1	1.21
40	5/63	4.5	1.1	2.30	1.3	1.1	1.23	1.5	1.1	1.28
42	6/63	1.3	1.1	1.17	1.6	1.1	1.23	1.4	1.1	1.23
52	10/63	1.5	1.0	1.20	1.6	1.1	1.38	1.6	1.3	1.44
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	3.6	1.0	1.35	--	--	--	--	--	--
58	5/64	--	--	--	1.5	1.3	1.43	1.9	1.4	1.60
61	6/64	2.3	1.0	1.32	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	1.6	1.3	1.41	1.9	1.1	1.32
67	9/64	2.0	1.1	1.50	--	--	--	--	--	--
Avg.				1.47			1.31			1.34

Michigan waters of Lake Erie not included.

TABLE 21

SILICA CONCENTRATIONS IN LAKE ERIE
mg/1

Cruise	Date	Western Basin			Central Basin			Eastern Basin		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	1.4	0.2	0.52	1.2	0.4	0.61
40	5/63	1.8	0.8	1.36	1.1	0.3	0.60	0.8	0.2	0.35
42	6/63	5.0	0.7	1.87	3.5	0.3	0.75	3.4	0.3	0.71
52	10/63	1.6	0.4	0.83	1.2	0.2	0.41	0.6	0.2	0.29
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	2.0	0.4	1.13	--	--	--	--	--	--
58	5/64	--	--	--	0.6	0.3	0.42	0.4	0.2	0.30
61	6/64	2.6	0.3	1.04	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	9.6	0.3	1.37	3.5	0.2	0.57
67	9/64	1.8	0.3	1.00	--	--	--	--	--	--
Avg.				1.20			0.68			0.47

Michigan waters of Lake Erie not included.

ALKYL BENZENE SULFONATE (ABS)

This compound (ABS), up until July 1965, was a constituent of synthetic detergents. It is difficultly degradable and is a rather stable part of receiving waters. In excessive quantities, more than 1 mg/l, it imparts a disagreeable taste and will foam. Much higher concentrations have not produced any toxic effects on humans, however, this has not been ascertained on aquatic life. The USPHS drinking water standards recommend a limit of 0.5 mg/l based on taste and foam production. This value in Lake Erie has not been exceeded.

The average concentration of ABS in the western basin water in 1963 and 1964 was 0.067 mg/l, in the central basin 0.065 mg/l, and 0.065 mg/l in the eastern basin (Table 22). Sample values ranged from 0.01 mg/l to 0.20 mg/l. Most nearshore areas range within the same values.

SOLUBLE PHOSPHORUS

Soluble phosphorus is a minor constituent, quantity-wise, in Lake Erie. It has no public health significance, nor is it an important factor in regard to chemical water quality in concentrations now found in the lake. However, its concentration is a very important controlling factor in Lake Erie's major water quality problem, the problem of eutrophication or the over-production of attached and planktonic plants. Phosphorus is a limiting nutrient.

The maximum, minimum, and average concentrations in each basin for all cruises are shown in Table 23. In the western basin of Lake Erie, soluble phosphorus, during the 1963-64 surveys, averaged 0.032 mg/l and ranged from 0.003 to 0.333 mg/l. The average was 0.010 mg/l in both the central and eastern basins. The range in the central basin was from 0.000 to 0.066 mg/l and in the eastern basin from 0.000 to 0.033 mg/l. Figure 44 shows phosphate (PO_4) values. Phosphorus is equal to one-third these values.

The input of soluble phosphorus from the upper lakes appears to be approximately 0.005 mg/l. If this is true, there is nearly a six-fold increase in the western basin of Lake Erie. However, this is followed by a 60 percent decrease in the phosphate level of the central and eastern basins. The decrease apparently results from both chemical and biochemical precipitation and biological storage within the lake. Figure 46 shows the soluble phosphorus distribution in the western basin for one cruise in September 1964 in which the west to east decrease is apparent.

Nearshore values generally are higher in the vicinity of tributaries and harbors. Maumee Bay averaged 0.027 mg/l of soluble phosphorus during the time of survey but apparently at times of heavy runoff the amount is higher. Concentrations of 0.066 or more are prevalent along the Michigan shore. Relatively high levels of phosphorus have been found in Sandusky

TABLE 22

ABS CONCENTRATIONS IN LAKE ERIE
mg/l

		Western Basin			Central Basin			Eastern Basin		
Cruise	Date	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	0.07	0.03	0.038	0.07	0.03	0.040
40	5/63	0.06	0.05	0.053	0.18	0.03	0.072	0.15	0.04	0.087
42	6/63	0.14	0.05	0.090	0.17	0.02	0.058	0.17	0.04	0.077
52	10/63	0.14	0.07	0.097	0.20	0.04	0.083	0.15	0.03	0.076
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	0.10	0.5	0.075	--	--	--	--	--	--
58	5/64	--	--	--	0.07	0.06	0.065	0.07	0.06	0.065
61	6/64	0.06	0.01	0.033	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	0.12	0.05	0.075	0.10	0.03	0.045
67	9/64	0.12	0.01	0.055	--	--	--	--	--	--
Avg.				0.067			0.065			0.065

Michigan waters of Lake Erie not included.

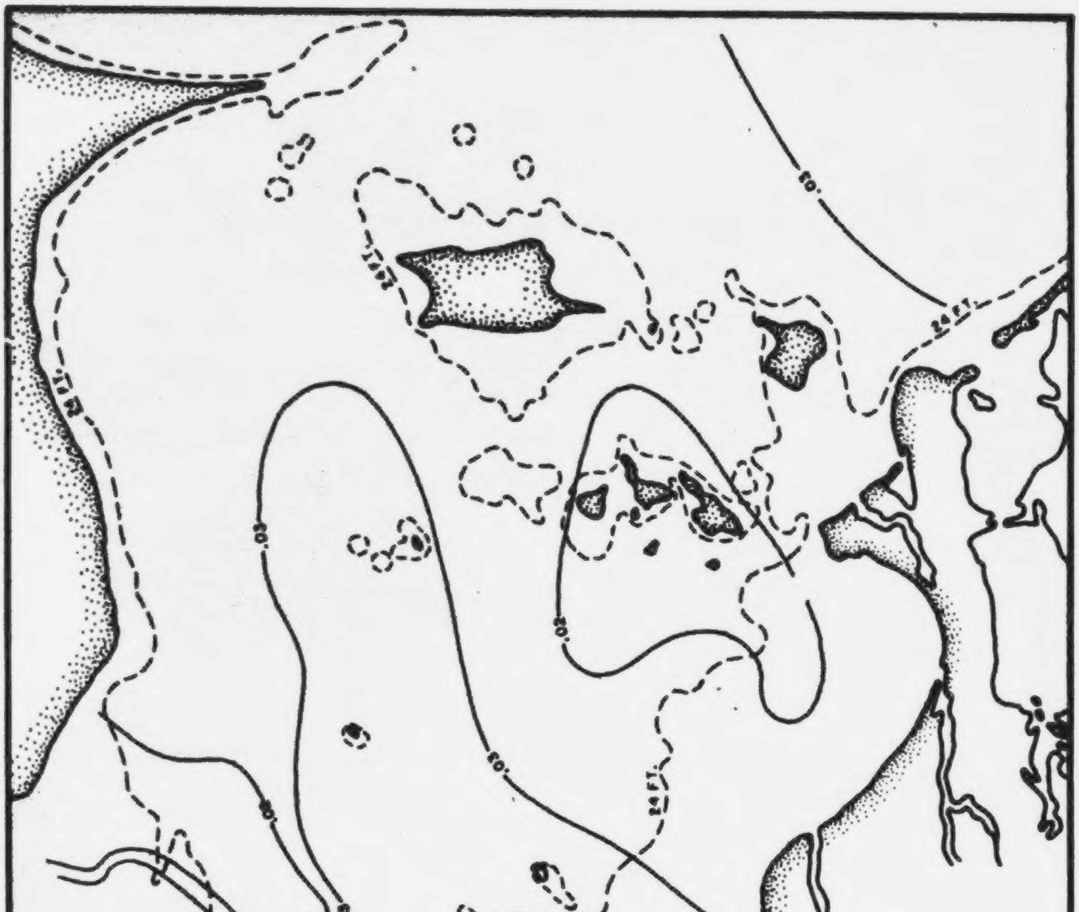
410<

TABLE 23

SOLUBLE PHOSPHORUS (P) CONCENTRATIONS IN LAKE ERIE
mg/l

Cruise	Date	Western Basin			Central Basin			Eastern Basin		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	0.020	0.003	0.009	0.017	0.003	0.009
40	5/63	0.024	0.007	0.014	0.020	0.003	0.011	0.017	0.007	0.011
42	6/63	0.010	0.007	0.009	0.040	0.003	0.005	0.033	0.003	0.009
52	10/63	0.017	0.003	0.008	0.023	0.000	0.008	0.027	0.000	0.006
55	4/64	0.333	0.007	0.068	0.027	0.007	0.014	0.017	0.010	0.014
57	5/64	0.030	0.007	0.013	--	--	--	--	--	--
58	5/64	--	--	--	0.037	0.000	0.012	0.037	0.000	0.013
61	6/64	0.240	0.024	0.080	--	--	--	--	--	--
66	8/64	--	--	--	0.066	0.000	0.013	0.024	0.000	0.006
67	9/64	0.123	0.003	0.034	--	--	--	--	--	--
Avg.				0.032			0.010			0.010

Michigan waters of Lake Erie not included.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SOLUBLE PHOSPHORUS (P) IN LAKE ERIE - WESTERN BASIN
SEPTEMBER 9-16, 1964
CONTOUR INTERVAL .01mg/l

FIGURE 46

Bay (up to 0.056 mg/l) and Lorain Harbor (up to 0.037 mg/l). The Cuyahoga River, in places, shows extremely high concentrations of soluble phosphorus. The outer harbor has not shown these high values, apparently because of chemical precipitation in the channel. The other harbors along Lake Erie have not shown abnormally high concentrations.

TOTAL PHOSPHORUS

Total phosphorus analyses were not made on mid-lake waters for this study. Total phosphorus includes both soluble and insoluble organic and inorganic phosphorus. It is apparent that phosphorus can change in biochemical processes from the soluble to insoluble form and vice versa. As a result, the measure of total phosphorus is more valid in the evaluation of nutrient potential than is soluble phosphorus determination.

Both total and dissolved phosphorus analyses were made in the Michigan waters of Lake Erie by the FWPCA Detroit River Enforcement Project. Those analyses showed an average concentration of 0.093 mg/l of total phosphorus and an average concentration of 0.053 mg/l of soluble phosphorus. The Bureau of Commercial Fisheries (Carr, personal communication, 1967), in a study of central basin waters off Lorain, Ohio in 1966, showed a total phosphorus average of 0.016 mg/l and a soluble phosphorus average of 0.006 mg/l. Data from the Ontario Water Resources Commission (Steggles, personal communication, 1965) indicate that of the total phosphorus discharged via the Grand River (Ontario), 56 percent was soluble at the time of survey. It appears then, in mid-lake, the proportion of total to dissolved phosphates is much greater, even though the concentrations are much less.

Analyses for total phosphorus at the National Water Quality Network station at the Buffalo water intake show concentrations of about 0.1 mg/l (Table 24). The values are reported to the nearest 0.1 mg/l. It is likely that if they were reported to the nearest 0.01 mg/l, the phosphorus levels would be something less than 0.1 mg/l.

NITROGEN

Nitrogen in Lake Erie is similar to phosphorus in that its effect on water quality is felt in its nutritional stimulus to plant growth. Under isothermal conditions, it is not a factor of importance in water supplies, however, during summer stratification, where water intakes are located beneath the thermocline, ammonia concentrations assume proportions where large increases in raw water chlorine demand must be satisfied.

Total nitrogen includes all forms, organic and inorganic found in water. Organic nitrogen is unavailable as a nutrient until it is oxidized to the inorganic forms.

The inorganic forms of nitrogen are elemental nitrogen, ammonia nitrogen (NH_3), nitrate nitrogen (NO_3), and nitrite nitrogen (NO_2). The

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TABLE 24

CHEMICAL ANALYSES
National Water Quality Network Stations

STATE NEW YORK
MAJOR BASIN NORTHEAST
MINOR BASIN LAKE ERIE-NIAGARA RIVER
STATION LOCATION LAKE ERIE AT
BUFFALO, NEW YORK

DATE OF SAMPLE			TEMP. (Degrees Centigrade)	DISSOLVED OXYGEN mg/l	pH	B.O.D. mg/l	C.O.D. mg/l	CHLORINE DEMAND		AMMONIA-NITROGEN mg/l	CHLORIDES mg/l	ALKALINITY mg/l	HARDNESS mg/l	COLOR (scale units)	TURBIDITY (scale units)	SULFATES mg/l	PHOSPHATES mg/l	TOTAL DISSOLVED SOLIDS mg/l	COLIFORMS per 100 ml.
MONTH	DAY	YEAR						1-HOUR mg/l	24-HOUR mg/l										
10	3	62	12.0	9.4	8.4	3.1	5	.9	2.8	.0	23	88	136	0	6	21	.1	223	*40
10	10	62	18.0	8.9	8.3	1.3	15	.6	1.4	.0	23	88	134	0	5	24	.1	254	*40
10	17	62	17.0	9.0	8.3	1.1	14	.9	1.7	.0	23	88	130	0	10	25	.1	192	43
10	24	62	14.5	9.3	8.2	2.6	14	.9	1.6	.0	20	88	138	0	14	27	.1	190	40
10	31	62	12.0	10.0	8.2	2.0	15	.9	1.8	.0	23	88	140	0	20	26	.1	207	24
11	8	62	10.5	10.0	8.2	1.5	10	1.2	2.6	.0	23	88	128	0	8	28	.1	180	60
11	14	62	10.0	10.8	8.2	1.7	12	.9	1.9	.0	23	86	140	0	7	20	.1	187	*4
11	21	62	10.0	11.0	8.2	2.2	16	.8	-	.0	23	88	138	0	12	20	.1	186	20
11	28	62	9.5	11.2	8.1	1.8	13	.6	1.8	.0	23	86	142	0	9	20	.1	193	*4
12	5	62	10.0	11.2	8.2	1.1	10	.8	1.1	.0	23	86	134	0	5	20	.1	185	10
1	2	63	11.0	14.0	8.1	1.8	10	.8	1.9	.0	23	88	138	0	33	21	.1	205	*4
1	9	63	5.0	13.5	-	1.5	11	.4	1.6	.0	23	88	136	0	12	21	.1	173	-
1	16	63	2.0	13.4	8.0	1.8	9	.5	1.9	.0	23	88	138	0	12	21	.1	188	*4
1	23	63	.0	13.5	8.2	1.2	12	.1	1.7	.0	23	90	128	0	11	21	.1	197	-
1	30	63	2.0	13.0	8.0	2.0	16	.4	1.7	.0	23	92	136	0	15	21	.1	189	-
2	6	63	2.5	13.5	8.2	1.7	16	.2	1.2	.0	23	88	132	0	9	20	.1	197	-
2	13	63	3.0	13.6	8.1	1.0	15	.2	1.6	-	23	90	134	0	7	20	.0	194	-
2	20	63	3.0	13.7	8.1	1.6	14	.8	2.2	.0	23	80	130	0	6	20	.1	190	*4
2	27	63	3.0	13.0	8.0	1.5	14	1.4	2.8	.0	23	90	134	0	7	20	.1	189	*10
3	6	63	3.0	13.5	8.1	1.1	14	1.4	3.0	.0	23	86	132	0	4	22	.1	197	*4
3	12	63	3.0	13.5	8.0	1.1	13	1.4	2.4	.0	23	92	134	0	14	22	.1	185	20
3	20	63	4.0	13.5	8.0	1.9	141	.8	2.2	.0	23	90	136	0	7	21	.1	201	*10
3	27	63	3.0	13.6	8.0	3.9	14	1.4	2.4	.0	23	88	138	0	7	22	.1	183	*40
4	3	63	4.0	13.4	8.1	1.2	11	.8	1.8	.0	23	84	132	0	10	20	.1	211	20
4	10	63	4.0	13.0	8.4	1.0	15	.4	1.2	.0	20	88	132	0	9	22	.1	180	*4
4	17	63	4.0	13.0	8.1	1.5	11	.6	1.8	.0	20	84	126	0	15	20	.1	175	20
4	24	63	5.0	14.0	8.2	1.7	11	.8	2.0	.0	23	86	136	0	5	20	.1	157	10
5	1	63	5.0	12.8	7.9	3.1	15	.8	1.2	.0	20	72	120	0	10	20	.1	156	*4
5	8	63	5.0	12.0	8.1	2.2	5	.8	2.2	.0	18	80	120	0	0	20	.1	184	-
5	15	63	10.0	12.2	8.2	2.0	18	.6	1.8	.0	23	80	132	0	10	20	.1	174	-
5	22	63	12.0	11.2	8.2	1.9	18	.8	1.8	.0	23	80	134	0	11	20	.1	197	20
5	29	63	13.0	11.8	8.4	2.2	17	.9	-	-	23	84	126	0	9	21	.1	197	64
6	4	63	19.5	11.5	8.5	2.1	15	.9	2.1	-	23	86	124	0	3	22	.1	194	-
6	12	63	18.0	9.0	8.3	2.0	17	1.6	4.0	.0	23	80	126	0	15	21	.1	185	-
6	19	63	20.0	9.5	8.5	2.8	14	.9	2.9	.0	23	84	126	0	15	20	.1	187	*4
7	3	63	25.0	8.0	8.4	2.5	7	.8	-	.0	20	84	128	0	40	20	.1	214	10
7	10	63	22.5	9.0	8.2	2.0	11	.9	2.2	-	23	86	124	0	5	21	.1	194	-
7	11	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*4
7	17	63	23.0	8.0	8.4	.8	9	.7	2.7	.0	23	84	124	0	7	21	.0	169	50

nitrogen cycle includes all these forms. The chemical and biological condition of the water gives rise to considerable variations in levels of each form present.

For the periods of the 1963 and 1964 surveys the total nitrogen content of the western basin averaged 0.71 mg/l and varied from 0.17 to 2.66 mg/l (Table 25 and Figure 44). In the central basin and the eastern basin, the levels were nearly identical with averages of 0.43 and 0.42 mg/l, respectively. The extremes were 0.10 and 1.30 mg/l. Figure 47 shows the total nitrogen distribution in the western basin for one cruise in September 1964.

Nitrite nitrogen and elemental nitrogen are not significant in the waters of Lake Erie since the oxidation-reduction potential is such to discourage duration of these forms. Ammonia nitrogen, for the periods of survey, averaged 0.159 mg/l in the western basin water and ranged from 0.01 to 9.77 mg/l (Table 26). In the central basin the average was 0.086 mg/l with a range of 0.00 to 0.39 mg/l. The eastern basin average was identical to that of the central basin and the range was nearly so, 0.00 to 0.32 mg/l.

Nitrate nitrogen averaged 0.124 mg/l in the western basin with a range of 0.02 to 1.50 mg/l (Table 27). In the central and eastern basins the averages were identical at 0.090 mg/l. The range in the central basin was 0.01 to 0.50 mg/l while in the eastern basin it was 0.01 to 0.85 mg/l.

Organic nitrogen averaged 0.36 mg/l in the western basin, 0.25 in the central basin, and 0.24 in the eastern basin (Table 28).

Nearshore areas, especially harbors, show widely varying nitrogen concentrations in all three measured forms. In the western basin, values approximately double the mid-lake concentrations, whereas in the central and eastern basins, the values are only slightly higher, on the average, than mid-lake (Table 29).

OTHER CHEMICAL CONSTITUENTS OF LAKE ERIE WATER

Analyses have been made for several metals in western basin water where concentrations exceed those in the remainder of the lake. Table 30 shows the acceptable limits listed in the 1962 U. S. Public Health Service Drinking Water Standards and the concentrations in western basin water for the listed metals.

TABLE 30

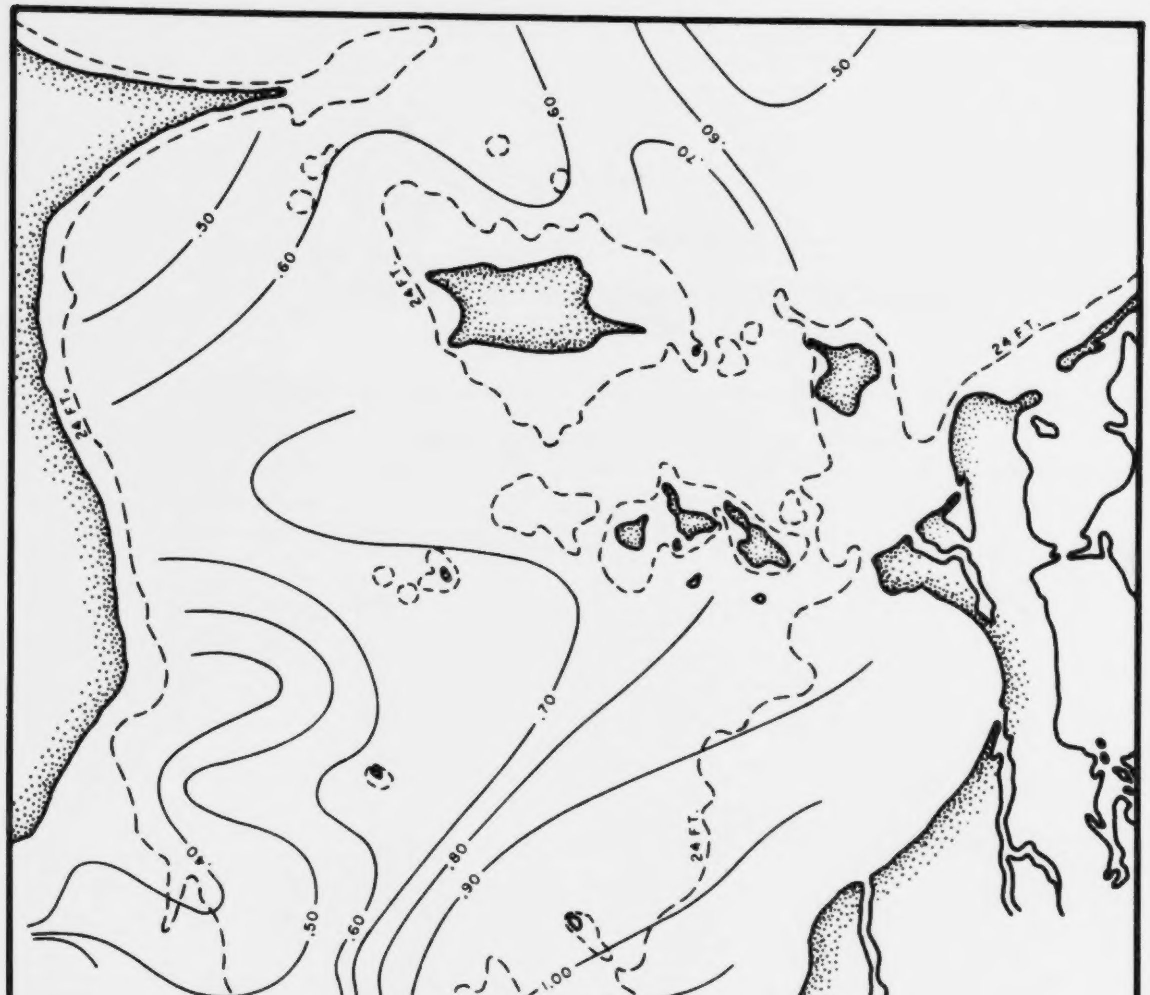
Substance	U.S. PHS Limit (mg/l)	Concentration Western Basin (mg/l)
Zinc	5.0	.00-.23
Copper	1.0	<.001
Cadmium	0.01	<.001
Nickel	--	<.001
Lead	0.05	<.001
Chromium	0.05	<.001

TABLE 25

TOTAL NITROGEN CONCENTRATIONS IN LAKE ERIE
mg/l

		Western Basin			Central Basin			Eastern Basin		
Cruise	Date	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	0.68	0.13	0.47	1.16	0.10	0.41
40	5/63	0.67	0.53	0.59	0.93	0.07	0.33	0.75	0.13	0.32
42	6/63	0.71	0.60	0.65	1.09	0.26	0.42	0.61	0.20	0.39
52	10/63	0.72	0.31	0.50	0.89	0.18	0.45	0.80	0.23	0.46
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	2.02	0.25	0.90	--	--	--	--	--	--
58	5/64	--	--	--	1.30	0.12	0.42	1.18	0.17	0.45
61	6/64	2.66	0.17	0.76	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	0.83	0.20	0.50	1.00	0.21	0.47
67	9/64	2.30	0.20	0.86	--	--	--	--	--	--
Avg.				0.71			0.43			0.42

Michigan waters of Lake Erie not included.



TOTAL NITROGEN IN LAKE ERIE - WESTERN BASIN
SEPTEMBER 9-16, 1964
CONTOUR INTERVAL .10 mg/l

.50
.60
.70
.50
.60
.50
.60
.70
.40
.50
.60
.80
.90
1.00
1.10
1.20
1.30
1.40
1.50
1.80
24 FT.
24 FT.
24 FT.
24 FT.
SCALE
5
0
5
10
N

FIGURE 47

TABLE 26

AMMONIA NITROGEN CONCENTRATIONS IN LAKE ERIE
mg/l

Cruise	Date	Western Basin			Central Basin			Eastern Basin		
		Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	0.10	0.02	0.055	0.32	0.01	0.104
40	5/63	0.09	0.04	0.055	0.11	0.00	0.031	0.27	0.00	0.046
42	6/63	0.26	0.09	0.160	0.23	0.06	0.128	0.29	0.08	0.135
52	10/63	0.19	0.03	0.083	0.17	0.02	0.068	0.22	0.02	0.058
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	0.23	0.07	0.143	--	--	--	--	--	--
58	5/64	--	--	--	0.23	0.01	0.089	0.27	0.01	0.082
61	6/64	0.60	0.04	0.256	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	0.39	0.04	0.144	0.31	0.02	0.094
67	9/64	0.77	0.01	0.258	--	--	--	--	--	--
Avg.				0.159			0.086			0.086

Michigan waters of Lake Erie not included.

TABLE 27

NITRATE NITROGEN CONCENTRATIONS IN LAKE ERIE
mg/l

		Western Basin			Central Basin			Eastern Basin		
Cruise	Date	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	0.13	0.02	0.052	0.06	0.01	0.019
40	5/63	0.25	0.02	0.113	0.13	0.02	0.047	0.17	0.02	0.039
42	6/63	0.06	0.02	0.040	0.84	0.02	0.063	0.03	0.01	0.018
52	10/63	0.29	0.09	0.157	0.42	0.03	0.111	0.47	0.01	0.091
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	--	--	--	--	--	--	--	--	--
58	5/64	--	--	--	0.50	0.00	0.121	0.52	0.06	0.207
61	6/64	1.50	0.03	0.287	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	0.36	0.01	0.146	0.85	0.07	0.164
67	9/64	0.54	0.02	0.148	--	--	--	--	--	--
Avg.				0.124			0.090			0.090

Michigan waters of Lake Erie not included.

TABLE 28

ORGANIC NITROGEN CONCENTRATIONS IN LAKE ERIE
mg/l

		Western Basin			Central Basin			Eastern Basin		
Cruise	Date	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.
9	4/63	--	--	--	--	--	0.36	--	--	0.29
40	5/63	--	--	0.42	--	--	0.25	--	--	0.24
42	6/63	--	--	0.45	--	--	0.23	--	--	0.24
52	10/63	--	--	0.26	--	--	0.27	--	--	0.31
55	4/64	--	--	--	--	--	--	--	--	--
57	5/64	--	--	--	--	--	--	--	--	--
58	5/64	--	--	--	--	--	0.21	--	--	0.16
61	6/64	--	--	0.21	--	--	--	--	--	--
62	6/64	--	--	--	--	--	--	--	--	--
66	8/64	--	--	--	--	--	0.21	--	--	0.21
67	9/64	--	--	0.45	--	--	--	--	--	--
Avg.				0.36			0.25			0.24

Michigan waters of Lake Erie not included.

TABLE 29

WATER QUALITY-NEARSHORE AND HARBORS
(mg/l or µmhos/cm)

Parameter	Michigan waters of Lake Erie Min	Michigan waters of Lake Erie Max	Maumee Bay Min	Maumee Bay Max	Sandusky Bay Min	Sandusky Bay Max	Lorain Harbor Min	Lorain Harbor Max	Cleveland Harbor Min	Cleveland Harbor Max	Fairport Harbor Min	Fairport Harbor Max	Ashtabula Harbor Min	Ashtabula Harbor Max	Erie Harbor Min	Erie Harbor Max
Cond (25°C)			280	460	256	800	300	340	--		330	5920	--		330	360
DS			200	290	190	680	160	230	180	370	180	6000	170	230	180	290
TS			200	350	210	760	170	270	180	680	190	6100	180	250	200	290
Chlor.	27	82	20	32	16	32	19	25	14	88	--		24	42	26	38
Sol PO_4	.05	.20	.02	.19	.02	.17	.02	.11	--		--		.02	.06	.01	.03
SO_4			--		25	256	27	37	--		--		--		26	44
SiO_2			0.6	1.7	0.3	5.9	.40	1.10	--		--		--		.3	.5
K			1.4	2.6	1.2	4.0	1.3	2.2	--		--		--		1.4	1.9
Mg			12	18	10	38	9	11	--		--		--		9	9
Ca			35	42	38	114	34	38	--		--		--		42	47
Na			12	20	10	16	10	13	--		--		--		17	21
ABS	<.025		.05	.15	.05	.20	.05	.15	--		--		--		.07	.14
Alk	78	157	86	120	87	120	88	99	81	130	90	110	94	100	90	96
pH	8.4	9.2	7.4	9.7	7.5	9.1	7.5	8.7	6.7	9.5	7.1	8.7	8.2	8.5	7.3	8.1
Temp			21	25	23	26	24	25	16	21	23	29	15	17	16	19
DO%S			60	95	65	115	80	95	70	95	80	130	95	110	Avg.	60%
BOD			1.5	4.0	2.1	6.3	1.0	2.3	--		--		2.0	5.6	Avg.	3.3
COD			12	53	13	42	10	28	8	22	8	12	7	11	Avg.	24
Phenol	0.0	0.058	--		--		--		--				--			
Total N			.82	3.45	.82	3.50	.50	4.20	--						.66	.80
Org N	0.20	0.30	.07	1.33	.53	2.30	.01	1.10	--				.29	.49	.30	.59
Amm N	0.20	0.30	.30	1.80			.12	.90	--				.03	1.55	.12	.23
Nit N	0.11	0.91	.00	.80	.01	1.80	00	2.90	--						.07	.14

Lake Erie contains no known chemical substances in quantities toxic to aquatic life or sufficient to cause any sort of health hazard to users of the water. This does not apply to tributary waters in highly industrialized areas where concentrations may, under certain conditions, be hazardous. Such areas exist at Detroit, Lorain, Cleveland, Fairport, and Ashtabula.

RADIOCHEMISTRY

Radioactivity is defined as the spontaneous emission of alpha, beta, or other radiation by the disintegration of unstable atomic nuclei. Naturally-occurring, radioactive isotopes usually decay (disintegrate) by stepwise emission of alpha or beta particles to form stable isotopes. An artificially produced radioisotope, however, generally decays in a single step by the emission of a beta particle.

Alpha and beta particles have the ability to ionize any matter with which they interact by the production of ion-pairs. It is the formation of such ion-pairs in biological tissue that results in cell destruction, impairment, or mutation.

Radioactive wastes discharged to the environment are not absorbed in harmless fashion. Even though decay and dilution may occur, radionuclides may be concentrated physically, chemically, and/or through biological assimilation and retention. As a result the radionuclide concentration will increase as it passes through the environment to the point of human contact.

Human exposure to radioactively contaminated surface water can result when the surface water is used as a public water supply. In addition, biologically concentrated radioactivity can be assimilated through the ingestion of fish and other aquatic life.

Prior to cessation of atmospheric nuclear testing, fallout was the most significant source of radioactive pollution to Lake Erie. Other possible sources are the atmospheric and drainage discharges of reactor plants and of licensed radioisotope users in the basin.

ALPHA ACTIVITY OF LAKE WATER SAMPLES

The annual mean concentrations of alpha radioactivity in suspended and dissolved solids observed in samples from Lake Erie were 0.6 and 1.6 pc/l, respectively, for 1963.

The highest averages and maxima in 1963 occurred near the mouth of the Black River where the suspended solids mean and maximum were 1.5 and 4.6 pc/l, respectively; and the dissolved solids mean and maximum were 5.2 and 12 pc/l, respectively.

All 1964 averages were low in alpha activity with none exceeding 5.3 pc/l.

BETA ACTIVITY OF LAKE WATER

All suspended solids average beta activities were low for both 1963 and 1964. The 1963 means ranged from 8.9 to 18 pc/l with a weighted mean of 14 pc/l; the 1964 mean, however, ranged from 3.9 to 9.5 pc/l with a weighted mean of 7.9 pc/l.

ALPHA ACTIVITY OF PLANKTON SAMPLES

The gross alpha radioactivity in plankton samples was less than one to 30 pc/gram of ashed weight for 1963 with a mean value of 8.3 pc/gram, and from less than one to 20 pc/gram with a mean of 8.7 pc/gram for 1964. These ranges and means are essentially the same. The radioactivity levels (both alpha and beta) in plankton are higher than in water due to the concentrating effect of biological materials. Published work (Williams, Swanson) has shown the effectiveness of Euglena and Chlorella in decontaminating water of cesium 137. In 6-days Euglena reduced the degree of contamination 69 percent - 96 percent in 34 days.

Since alpha activity is usually associated with naturally occurring radioisotopes, and such isotopes, being of high atomic number, seldom appear as components of plankton, low alpha activities for plankton can be expected.

BETA ACTIVITY OF PLANKTON SAMPLES

Gross beta values range from 33 to 1200 pc/gram with a mean of 160 pc/gram for 1963, and from 76 to 400 pc/gram with a mean of 190 pc/gram for 1964. The ranges are similar except for the value of 1200 pc/gram which came from a sample collected off the tip of Long Point toward the east end of the lake.

CHAPTER 4

LAKE ERIE BIOLOGICAL CHARACTERISTICS

Aquatic biological life is sensitive to physical and chemical changes in its environment. Biological effects are often relatively extreme, and for this reason, the aquatic community is an excellent indicator of water quality. The important considerations are the total population, types, and relative numbers of each type. Pristine water and its bottom sediment contain a low total population, many types, and low numbers of each type. As water is degraded, the total population increases, the number of types decrease, and the numbers of a few resistant types increase greatly.

The total numbers increase because of increased nutrient content in the water. Organisms which more readily take advantage of high nutrient content and organic sediments begin to predominate. Bottom organisms which can withstand extended periods with little or no oxygen may replace those requiring an abundant oxygen supply. Plankton and fish populations change to those which are less desirable from a human standpoint. Plankton may cause taste and odor problems in water supplies and the clogging of intakes and filters. "Rough" fish may replace those prized for their edibility.

Lake Erie is presently experiencing rather dramatic changes in its biological productivity. These changes are not at the natural sequence rate, and can be related directly to man's activities.

Lake Bottom Biology

The benthic fauna are minute animals which live on and within the lake bottom sediments. Some have been classified, rather non-precisely, as "pollution-tolerant" or "pollution-sensitive". This classification rests on the ability of an organism to withstand periods of deficiency or absence of dissolved oxygen and does not imply that some organisms might prefer a lack of oxygen. Accordingly, these terms will be used in the following narrative.

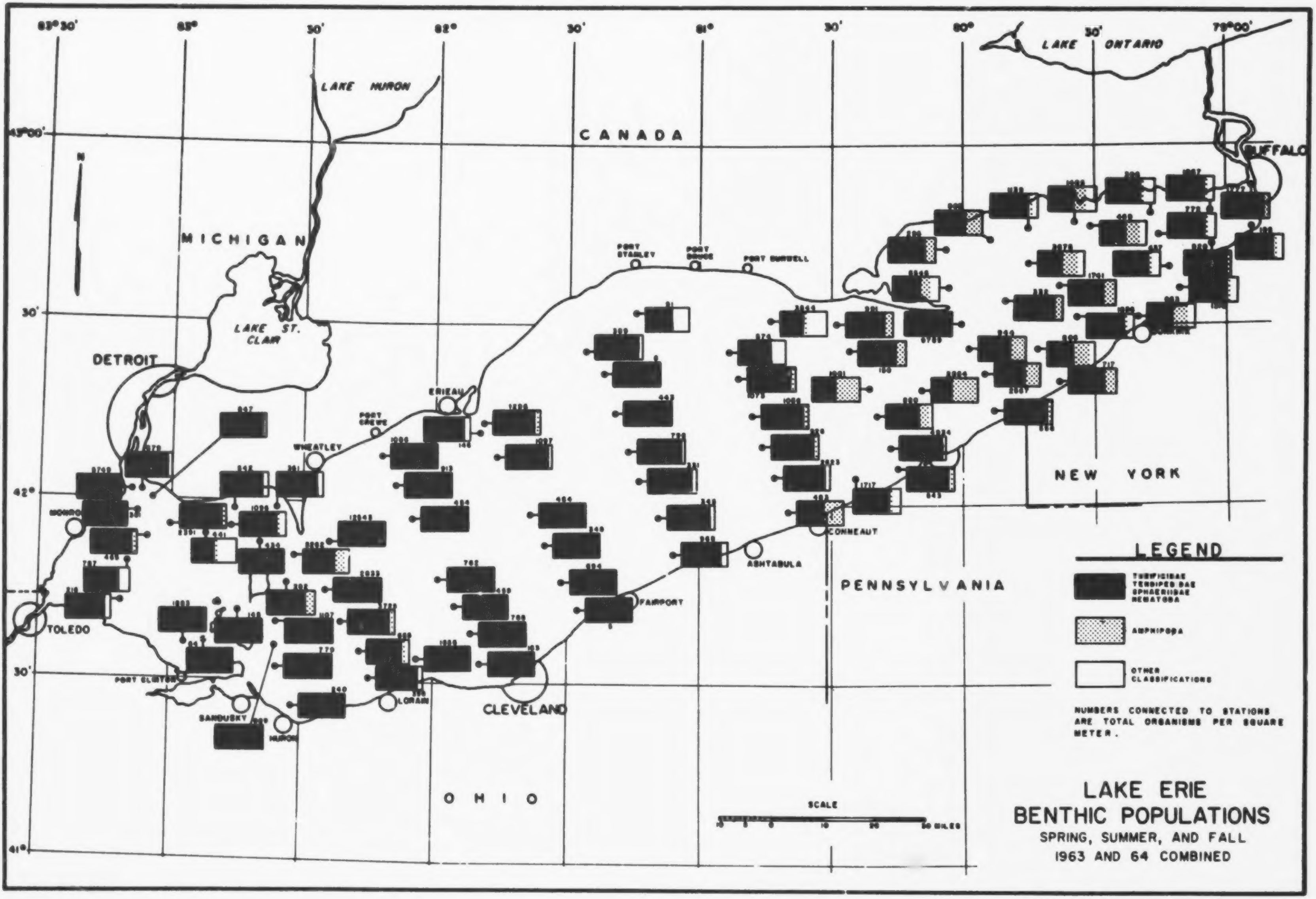
Studies conducted by the U. S. Bureau of Commercial Fisheries between 1929 and 1959 (Beeton, 1961 and Wright, 1955) and personnel at the Franz Theodore Stone Institute of Hydrobiology (Britt, 1955 a and b) show significant changes in population, type, and habitat of bottom-dwelling organisms in western Lake Erie. Pollution-tolerant forms have increased greatly along the west side of the basin and in the island area. These include Tubificidae, Sphaeriidae, and Tendipedidae. As an example in the island area, Tubificidae have increased from 10 organisms per square meter in 1929 to 550 organisms per square meter in 1957. During the same period Tendipedidae increased from 60 to 300 organisms per square meter. The Sphaeriidae showed a three-fold increase at two index stations near South Bass Island.

The pollution-sensitive caddis fly larvae (Tricoptera) and the mayfly (Hexagenia spp.) have been drastically reduced in numbers. Beeton (1961) reported that the formerly abundant Tricoptera larvae averaged less than one per square meter in 1957. The burrowing mayfly nymph, which lives in soft mud and feeds on detritus, was the most common macroinvertebrate in the western basin prior to the early 1950's. Wright (1955) found 285 and 510 nymphs per square meter in 1929 and 1930, respectively, in the island area. Chandler (1963) summarized studies made between 1942 and 1947 and reported an average of 350 nymphs per square meter for that period. Wood (1963) found an average of 235 per square meter for 204 samples collected in 1951 and 1952. In June 1953 Britt (1955) found approximately 300 nymphs per square meter. After sampling again in September following a five-day period of thermal stratification and bottom oxygen depletion Britt found only 44 nymphs per square meter. The succeeding year showed a good recovery but Beeton in 1959 found only 39 per square meter. In June 1964 the U. S. Public Health Service found only two nymphs in samples from 47 island area sites. None were found in the Michigan waters of the basin.

Published quantitative data are not available on the bottom fauna of central and eastern Lake Erie. Newspaper articles, dating back to 1927 describe "immense swarms" of mayflies blown into the city of Cleveland. A decline was first noted in 1949 but they reappeared in 1950 and were reported yearly through 1957. They were not reported after 1958.

Ferguson (personal communication), on a transect between Port Burwell and Conneaut in the spring and summer of 1958, showed populations of Tubificidae, Tendipedidae, Sphaeriidae, Amphipoda, Tricoptera, and Gastropoda. Gut contents of blue pike demonstrated that the pollution-sensitive Tricoptera and Amphipoda were common food.

The results of bottom fauna surveys of Lake Erie by the U. S. Public Health Service in 1963 and 1964 are summarized in Figure 48. It shows the relative abundance of the pollution-sensitive scud to the more tolerant sludgeworms, bloodworms, fingernail clams and nematodes. Figure 49 divides the lake into four zones based on the benthic fauna populations. It is evident that most of the western and central basins were characterized by the lack of pollution-sensitive scud and preponderance of pollution-tolerant species of sludgeworms, bloodworms, fingernail clams, and nematodes. A few areas in the western basin, the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83°
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79°00'
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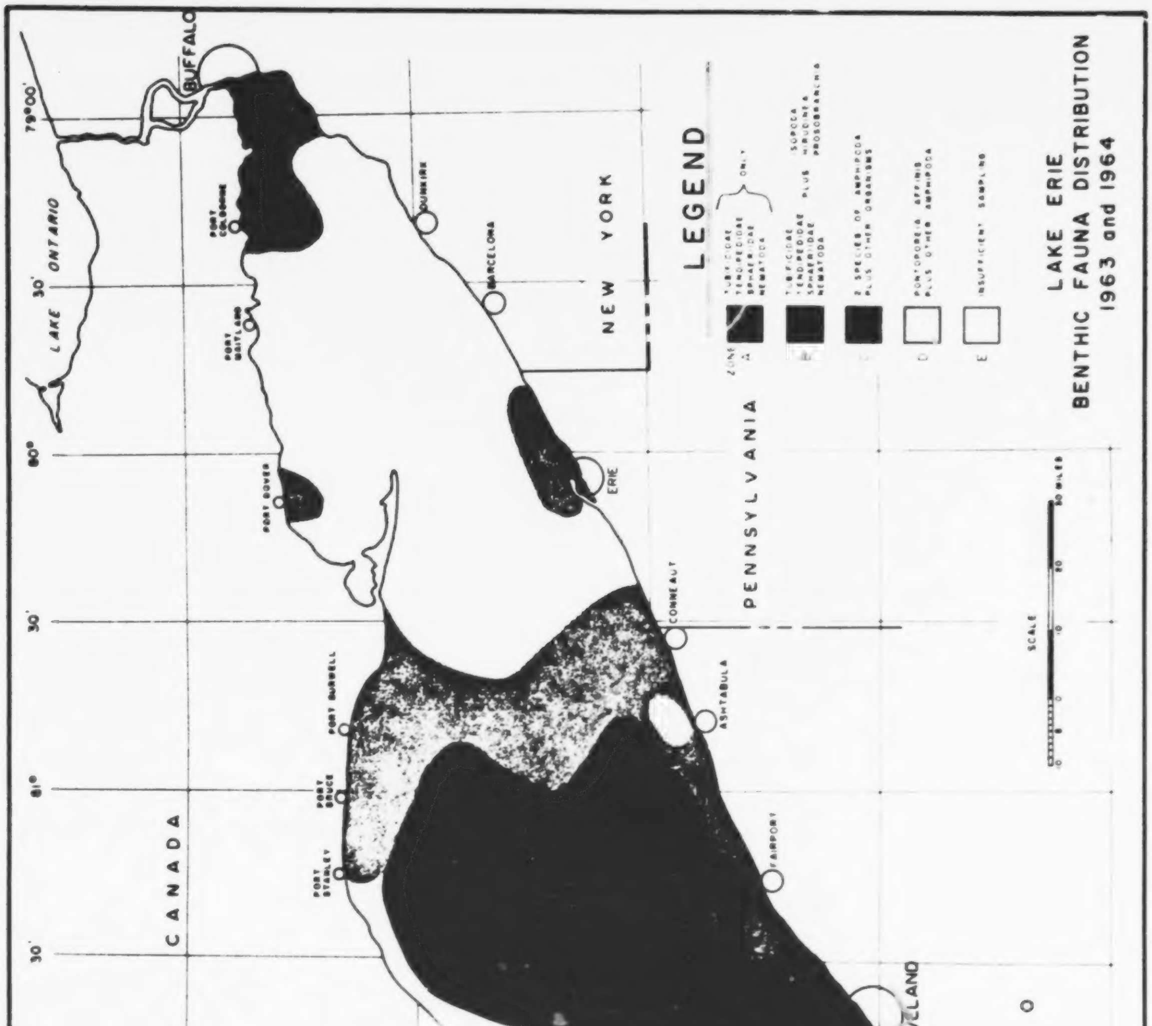
N
LAKE HURON
LAKE ONTARIO
CANADA
MICHIGAN
LAKE ST. CLAIR
DETROIT
MONROE
TOLEDO
PORT CLINTON
SANDUSKY
HURON
LORAIN
CLEVELAND
FAIRPORT
ASHTABULA
CONNEAUT
DUNKIRK
BUFFALO
WHEATLEY
PORT CREWE
ERIEAU
PORT STANLEY
PORT BRUCE
PORT BURWELL
OHIO
PENNSYLVANIA
NEW YORK
LEGEND
TUBIFICIDAE TENDIPEDIDAE SPHAERIIDAE NEMATODA
AMPHIPODA
OTHER CLASSIFICATIONS
NUMBERS CONNECTED TO STATIONS ARE TOTAL ORGANISMS PER SQUARE METER.
SCALE
10
0
10
20
30 MILES

LAKE ERIE
BENTHIC POPULATIONS
SPRING, SUMMER, AND FALL
1963 AND 64 COMBINED

FIGURE 48

426<


LEGEND
ZONE A TUBIFICIDAE TENDIPEDIDAE SPHAERIIDAE NEMATODA ONLY
B TUBIFICIDAE TENDIPEDIDAE SPHAERIIDAE NEMATODA PLUS ISOPODA HIRUDINEA PROSOBRANCHIA
C 2 SPECIES OF AMPHIPODA PLUS OTHER ORGANISMS
D PONTOPOREIA AFFINIS PLUS OTHER AMPHIPODA
E INSUFFICIENT SAMPLING
SCALE
0
10
20
30 MILES
LAKE ONTARIO
LAKE HURON
LAKE ST. CLAIR
CANADA
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
BUFFALO
PORT COLBORNE
DUNKIRK
BARCELONA
PORT MAITLAND
PORT DOVER
ERIE
CONNEAUT
ASHTABULA
PORT BURWELL
PORT BRUCE
PORT STANLEY
FAIRPORT
CLEVELAND
ERIEAU
LORAIN
VERMILION
PORT CREDE
WHEATLEY
HURON
LEAMINGTON
KINGSVILLE
SANDUSKY
PORT CLINTON
DETROIT
MONROE
TOLEDO
N
79°00'
30'
80°
30'
81°
30'
82°
30'
83°
83°30'
43°00'
30
42°
30
41°

LAKE ERIE
BENTHIC FAUNA DISTRIBUTION
1963 and 1964

FIGURE 49

eastern part of the central basin, and the eastern basin support a good population of pollution-sensitive scud and are indicative of the more favorable environmental conditions in these areas. The four zones shown in Figure 49 are described as follows:

Zona A - Contains only the pollution-tolerant groups, sludgeworms, fingernail clams, nematodes, and pollution-tolerant species of bloodworms.

Zone B - In addition to groups in Zone A, the following groups of intermediate tolerance were found: aquatic sowbugs, snails, leeches, and several additional species of bloodworms.

Zone C - May contain any organisms found in Zones A and B but the two species of scuds (Gammarus fasciatus and/or Hyalella azteca) are always present.

Zone D - May contain any group of organisms listed in Zones A, B, and C but always contains the intolerant scud (Pontoporeia affinis).

Zones C and D had the greatest variety of bottom-dwelling organisms and were characterized by the presence of scuds at each station. Gammarus fasciatus was found regardless of bottom type and Hyalella azteca was present at many locations associated with a sand, gravel, or rock bottom. Pontoporeia affinis which requires cold, deep, clear, and well-oxygenated water occurred only in Zone D.

The variety of bloodworms is also important. All lakes have a variety of bloodworm (midge) larvae as part of the benthic fauna, and their habitats vary according to the quality of the overlying water. Curry (Unpublished) classified the larvae according to one of four categories depending upon their environmental requirements. The categories (1) Pollution-tolerant, (2) Cosmopolitan, (3) Clean-Water, and (4) Others, adequately covered the 38 species identified in Lake Erie.

The Pollution-tolerant species include larvae existing even for a short period of time in habitats having sediments with a high percentage of organic matter, low dissolved oxygen, rather high temperatures, and possible septic conditions. The Clean Water species included larvae that were found in the colder, deeper waters of oligotrophic lakes and streams. In these areas the temperatures were lower, dissolved oxygen high, and septic conditions were never present. Larvae classified as Cosmopolitan species were found in both pollution-tolerant and clean-water environments. The Other species group included larval forms found only occasionally in any bottom samples. Usually these larvae were restricted to isolated regions of the lake. This could be due to one or more factors including depth, temperature, food, carbon dioxide, or oxygen.

Of the 38 identified species in the lake, 54 percent were Pollution-Tolerant, 43 percent Cosmopolitan, 1 percent Clean Water, and 2 percent Other. The population of bloodworm larvae inhabiting the central portion of Zone A was composed of 80 percent Pollution-Tolerant species. Zone A is also the area that contained the fewest number of species of bloodworm larvae. Curry, in unpublished data, gives a more detailed treatment of the bloodworm distribution data.

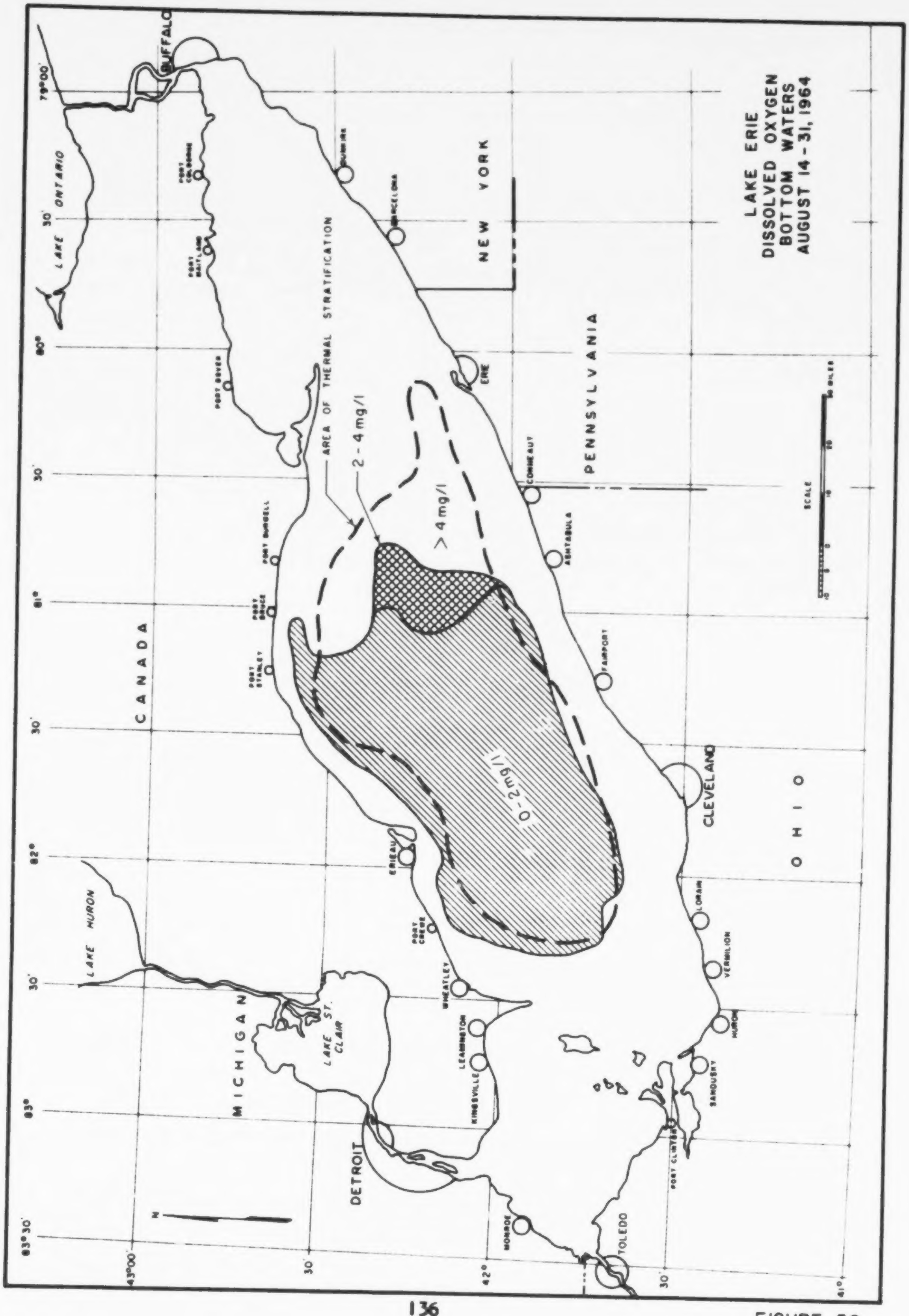
Dissolved oxygen data from studies conducted by the Public Health Service, Bureau of Commercial Fisheries, and the Great Lakes Institute are summarized in Figure 50. This map shows that Zone A is approximately the area in which dissolved oxygen concentrations of less than 2.0 mg/l have been found in the hypolimnion during the summer. Not only was the number of species much less in the area of low dissolved oxygen, but the following table indicates that total numbers were lower as well. Stations chosen for this comparison were between 13 and 22 meters deep where a persistent thermocline is present from mid-June to mid-September. Bottom deposits were mostly mud in the low dissolved oxygen area and mud and sand in adjacent areas.

BENTHIC FAUNA
Number of Organisms per square meter

	West of Low DO area		Low DO Area		East of Low DO area	
	Spring	Fall	Spring	Fall	Spring	Fall
Tubificidae	1,850	1,830	186	1,460	354	2,300
Tendipedidae	47	407	39	156	107	278
Sphaeriidae	350	502	187	137	162	307
Amphipoda	1	7	0	0	69	465
Other	121	145	26	31	73	221
Total	2,369	2,891	438	1,784	765	3,571

The dissolved oxygen deficit not only limits the number of species but limits the total numbers as well, even though the sediments are higher in organic matter.

Zone B is a transition area where the pollution-intolerant scuds, mayflies, unionid clams, and caddis flies were absent. Intermediately tolerant forms such as the aquatic sowbug (Asellus militaris), snail (Gastropoda), and leech (mostly Helobdella sp.) were found. Zone B approximates the area where dissolved oxygen was between 2.0 and 4.0 mg/l in the hypolimnion during the summer of 1964.


LAKE ERIE
DISSOLVED OXYGEN
BOTTOM WATERS
AUGUST 14 - 31, 1964
AREA OF THERMAL STRATIFICATION
2 - 4 mg/l
> 4 mg/l
0 - 2 mg/l
CANADA
MICHIGAN
OHIO
PENNSYLVANIA
NEW YORK
LAKE HURON
LAKE ST. CLAIR
LAKE ONTARIO
BUFFALO
DETROIT
TOLEDO
CLEVELAND
ERIE
CONNEAUT
ASHTABULA
FAIRPORT
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
MONROE
KINGSVILLE
LEAMINGTON
WHEATLEY
ERIEAU
PORT STANLEY
PORT BRUCE
PORT BURWELL
PORT DOVER
PORT MAITLAND
PORT COLBORNE
DUNKIRK
BARCELONA
SCALE
N
83°30'
83°
30'
82°
30'
81°
30'
80°
30'
79°00'
43°00'
30'
42°
30'
41°

136

FIGURE 50

430

The distribution of the mayfly nymph (Hexagenia spp.) is difficult to plot graphically because of erratic occurrence. This genus can apparently survive only a short time when dissolved oxygen in the water is less than 4.0 mg/l and water temperature relatively high. The genus rarely occurs in water deeper than 50 feet, and since it requires a soft bottom its absence cannot always be attributed to poor water quality. Data from inshore stations where bottom type and depth were suitable for Hexagenia spp. showed the nymph was absent along the south shore except at one station northeast of Ashtabula. Hexagenia was abundant at all stations in Long Point Bay and in small numbers at most suitable locations near the Canadian shore of the eastern basin. A few Hexagenia spp. nymphs were found near the Canadian shore at the mouth of the Detroit River in 15 feet of water and near Colchester and Kingsville, Ontario.

A special study was conducted in the island area of Lake Erie in June 1964, to determine Hexagenia populations where they were formerly the most abundant macroinvertebrate inhabiting the bottom. The entire island area was sampled at 47 stations and only two nymphs were found. The bottom dwelling animals, except in shallow rocky areas, were predominately sludgeworms, bloodworms, and fingernail clams with only a few unionid clams and snails.

LAKE WATER BIOLOGY

ALGAE

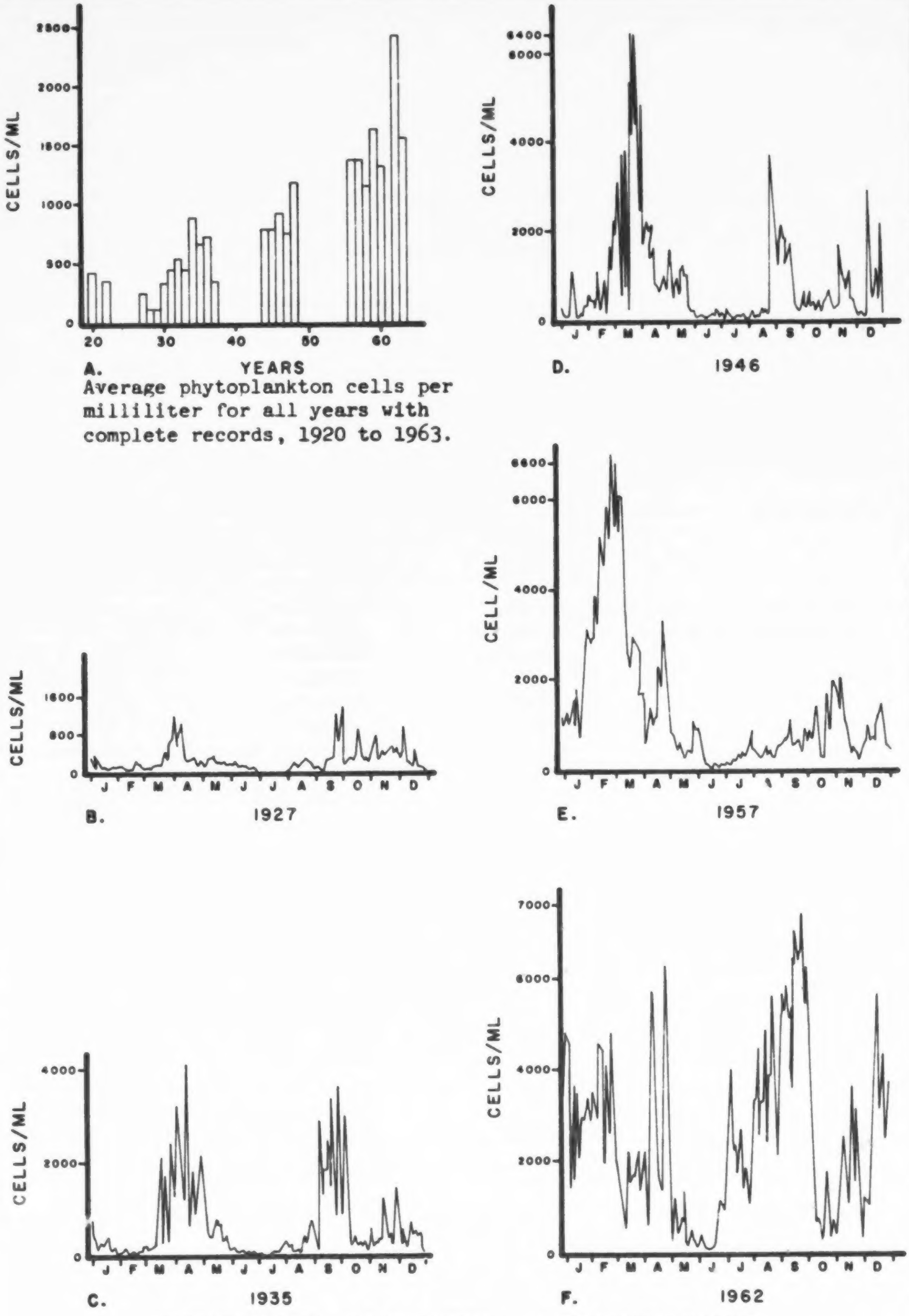
Algae are indicators of water quality. Increases in total productivity and decreasing variety indicate degradation resulting from increased nutrient content in the water.

Increases in productivity of both phytoplankton and the filamentous green alga, Cladophora sp., have been noted in the literature. Nuisance growths of Cladophora have been reported for many years in the island area (Langlois, 1954). However, in recent years island residents report the problem has become worse. Reports indicate that Cladophora nuisance problems have also increased on beaches around Erie, Pennsylvania and on New York beaches in the last several years. Neil and Owen (1964) report many Canadian beaches are also experiencing increased problems.

Chandler (1940, 1944) and Chandler and Weeks (1945) evaluated extensive phytoplankton, chemical, and physical data collected between 1938 and 1942 around the Bass Islands. It was concluded that phytoplankton populations were highly variable from year to year and that phytoplankton productivity based on only one year could be misleading. Chandler and Weeks believed these variations to be related to physical changes such as temperature, turbidity, and solar radiation rather than chemical changes. During the study period, diatoms never comprised less than 27 percent of the total, and total numbers never exceeded 1,000,000 units per liter. Blue-green algae were rarely predominant and never exceeded 52 percent of the total. Generally, the predominant spring genera were Synedra, Asterionella, Fragilaria, Tabellaria, and Cyclotella. Casper (1965) indicated that productivity had increased significantly and species composition changed to a great degree since 1942. Samples collected around the island area in September 1964 gave total counts of up to 3,500,000 units per liter with blue-greens comprising 70 percent of the total. Samples collected in April 1964 also yielded higher counts than any reported during the 1938-1942 study.

Davis (1964) has summarized plankton data accumulated by the Cleveland Division Avenue Filtration Plant since 1919. Although yearly variations are large, a definite long-term increase in plankton productivity is apparent as shown in Figure 51. The data show that plankton counts have increased from a yearly average of 200-400 cells/ml between 1920 and 1930 to a current average of 1,500-2,300 cells/ml. This indicates an increase in algal concentration of between 500 and 700 percent in the Cleveland area. The data also indicate an increase in duration of pulses. A pulse is a profusion of algae at a certain period of the year. Comparing the phytoplankton abundance between 1927 and 1962, Figure 51F, the increase in duration is very apparent. The spring and autumn pulses in 1927 occurred from March to April and from late August to mid-September, respectively. In 1962, the spring and autumn pulses occurred from mid-February to mid-April and from mid-June to mid-September, respectively. Correspondingly, the lows are now shorter in duration and numbers of phytoplankton per milliliter have increased considerably. There has also been a significant change in dominant genera of the spring and autumn phytoplankton pulse as indicated in Table 31. The dominant spring genera have changed from Asterionella to Melosira. A corresponding shift in the fall pulse has been from Synedra to Melosira to Fragilaria. During recent years the autumn pulse has shown an increase in importance of green and blue-green algae such as Pediastrum, Anabaena, and Oscillatoria replacing in part the previous dominance by diatoms. Burkholder (1960), in the central and eastern basin in 1928-29 showed that diatoms were the dominant group of phytoplankters during June and July while in August the ratio of diatoms to green and blue-greens decreased. By mid-September, however, the diatoms once again were by far the dominant group. The data also showed that concentrations of phytoplankton never exceeded 2,000 per liter.

During the spring and summer of 1964, U. S. Public Health Service personnel made several visits to the island area of western Lake Erie to determine the extent of Cladophora growths. Around the islands, the rocky shorelines and reef areas provide an ideal substrate for Cladophora attachment. Under these conditions the major factors influencing abundance are nutrient supply, solar radiation, turbidity, and adequate wave action.



A. Average phytoplankton cells per milliliter for all years with complete records, 1920 to 1963.

B. 1927

C. 1935

D. 1946

E. 1957

F. 1962

PHYTOPLANKTON ABUNDANCE

LAKE ERIE (CLEVELAND WATER INTAKE RECORDS)

FIGURE 51

TABLE 31

DOMINANT PHYTOPLANKTERS DURING SPRING AND AUTUMN PHYTOPLANKTON PULSES, 1920-63*
(The dash signifies that there was no pulse)

Spring pulse	Year	Autumn pulse
Asterionella	1920	Synedra
--	1921	Synedra
Asterionella	1922	Synedra
--	1923	Synedra
Asterionella	1927	Melosira, Synedra
--	1928	Synedra, Melosira, Stephenodiscus
--	1929	Asterionella, Melosira
--	1930	Melosira
Synedra, Asterionella	1931	Melosira
Asterionella, Melosira	1932	Melosira
--	1933	Melosira
Asterionella	1934	Melosira
Asterionella	1935	Melosira
Asterionella	1936	Melosira
Melosira, Synedra	1937	Synedra, Melosira
Asterionella	1941**	Melosira
Asterionella	1944	Melosira
Asterionella	1945	Synedra, Melosira
Asterionella, Melosira	1946	Synedra, Melosira
Melosira, Asterionella	1947	Melosira, Synedra
Asterionella, Cyclotella	1948	Melosira, Pediastrum
Asterionella	1949	Melosira, Asterionella
?	1955	Synedra, Pediastrum
Melosira	1956	Melosira
Melosira	1957	Synedra, Melosira
Fragilaria, Melosira	1958	Pediastrum, Fragilaria
Melosira	1959	Fragilaria, Melosira, Anabaena
Fragilaria, Tabellaria	1960	Fragilaria
Melosira	1961	Melosira
Melosira	1962	Fragilaria, Melosira, Anabaena
Melosira	1963	Melosira, Anabaena, Oscillatoria
		Fragilaria, Synedra, Stephanodiscus

* Some of the included information has been adapted from an undergraduate project written by Mr. John Wolk.

** From Chandler's (1944) report of the Filtration Plant records for 1941.

Around Kelleys Island the water is usually clear and secchi disc readings were 8-12 feet except during heavy phytoplankton blooms when readings of less than two feet were recorded. Observations by scuba divers revealed heavy Cladophora growths extended from the surface to a depth of 11 feet and then gradually decreased until extinction at a depth of 15 feet. At maturity in late June and early July, strands of algae three to six feet in length were common. Growths were heaviest on the east side of Kelleys Island around Gull and Kelleys Island shoals. The more turbid waters around the Bass Islands did not permit adequate light penetration for growths in water depths greater than 5 feet. The investigation detected approximately four square miles covered with luxurious Cladophora growth in the island region alone.

Throughout the island region, and along the shores of Lake Erie, where the conditions are suitable, generally along rocky shores, these heavy growths exist. Upon maturity, wave action, etc., the strands of algae are broken from their attachment enabling wind and currents to deposit the massive quantities of Cladophora on beaches, in harbors, and in deeper waters of the lake. It has also been noted that mats of decomposing algae settle to the bottom in the central basin (Zone A of Figure 49) and become part of the sediment after decomposition.

During interviews, local residents reported that growths have been increasing rapidly in the past 20 years and that each succeeding year was becoming worse. Canada and other communities along the lake shore are experiencing this increasing problem.

It is clear from the literature that phytoplankton productivity in Lake Erie is highly variable from year to year and evaluation of phytoplankton data based on one or two years sampling could be misleading. Extreme care must be taken in comparing data under these conditions. Due to limited phytoplankton analysis from 1963 and 1964 the data will be treated generally to show ranges and to illustrate seasonal variations in productivity and species composition.

The phytoplankton data were averaged from all stations and separated according to basins and seasons. The tables below illustrate differences between diatoms and others which consisted of green and blue-green algae forms for each basin and season.

PHYTOPLANKTON 1963 - 1964
Diatoms vs. Total Number of Organisms
(Percent)

Basin	Diatom - Spring	Diatom - Fall	Total Annual Average
Western	79.2	3.0	8.8
Central	44.4	12.9	27.3
Eastern	49.8	35.4	40.0

PHYTOPLANKTON 1963 - 1964
Greens and Blue-greens vs. Total Number of Organisms
(Percent)

Basin	G-BG - Spring	G-BG - Fall	Total Annual Average
Western	20.8	97.0	91.2
Central	55.6	87.1	72.7
Eastern	50.2	64.6	60.0

The data show a spring pulse composed primarily of diatoms in the western basin, mainly Cyclotella-Stephanodiscus. It is indicated that diatom blooms occur in the western basin during the spring when the dissolved silica content is high. Diatoms assimilate silica in skeletal formation. The spring diatom pulse was also noted in the central and eastern basin but not to the extent of that in the western basin. It was followed by a low level summer population composed mainly of diatoms in the central and eastern basins and greens or blue-greens in the western basin. Due to lack of data, a comparison was not made with the other seasons. In late summer and early fall another pulse developed in which greens and blue-greens were dominant over the entire lake. Greens and blue-greens comprised a much higher proportion of the total population in all basins as indicated by the table of percentages. The following table shows populations and types of algae with reference to basin and season. As expected, the decreasing west to east trend is very pronounced when considering the total averages.

PHYTOPLANKTON
Average Numbers of Organisms per ml

Type of Algae	Season	Basin Western	Basin Central	Basin Eastern
Green Blue-green	Spring	375	650	290
Diatom	Spring	1,430	520	285
Total	Spring	1,805	1,170	575
Green Blue-green	Fall	10,475	875	115
Diatom	Fall	325	130	65
Total	Fall	10,800	1,005	180
Total	Average	8,000	1,100	300

436<

An extensive blue-green and green phytoplankton bloom in western Lake Erie was investigated in September 1964 (Casper, 1965). The bloom, covering approximately 800 square miles, consisted primarily of Oscillatoria sp., Aphanizomenon holsaticum, Anacystis cyonea, and Glenodiniam sp. Average numbers were 28,600 organisms per ml with a maximum of 170,000 organisms per ml. According to residents of the area these massive blooms have been occurring for a number of years but the intensity, frequency, and duration have been increasing.

FISH

The changes in the algal productivity of Lake Erie have been accompanied by changes in the fish populations. As far as man is concerned the changes over the years have been for the worse. Fish desirable for human consumption have declined in abundance (Figure 52) and have been replaced by less desirable species.

Man is responsible for the accelerated eutrophication of Lake Erie with its consequent changes in the quality and quantity of fish present. He catches the desirable fish when available with great efficiency, and returns the less desirable; he directly alters the fish habitat by introducing his wastes to the water and sediment. The resulting turbidity, oxygen depletion, and toxicity have eliminated preferred fish food forcing the desirable fish to vacate and spawn elsewhere. The less desirable species then proliferate since competition for available food has decreased. Unfortunately most of man's activities have been detrimental.

Commercial fish catch statistics, gathered by the U. S. Bureau of Commercial Fisheries, have provided a long record of the relative abundance of desirable fish species in Lake Erie (Tables 32 and 33 and Figure 52). In recent years, continuing surveys have been introduced by federal and state agencies on the reproductive phase of the life cycles of fishes and limited predictions of future populations are now possible.

The sturgeon almost disappeared from catch statistics at about the turn of the century. The cisco, once the dominant species of the commercial catch, experienced a sudden decline in 1926, showed a slight recovery, and declined to insignificance in 1957. Whitefish declined drastically in the commercial catch in 1955. The walleye began a drastic decline in 1957 and is still in great distress. The blue pike, which formerly produced several million pounds per year became nearly extinct in 1958.

The yellow perch has managed to hold its own, but it also shows signs of weakening in the commercial catch. It is the only plentiful fish remaining of the former many prized varieties. The smelt is now commercially exploitable and it, along with yellow perch, is sustaining the fishing industry in Lake Erie.

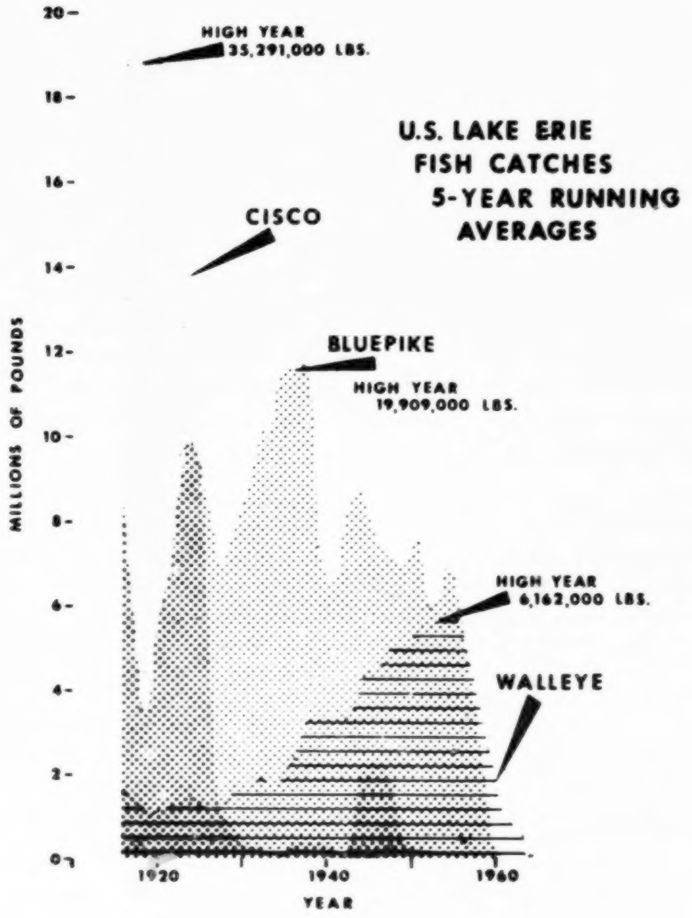

U.S. LAKE ERIE
FISH CATCHES
5-YEAR RUNNING
AVERAGES
HIGH YEAR
35,291,000 LBS.
CISCO
BLUEPIKE
HIGH YEAR
19,909,000 LBS.
HIGH YEAR
6,162,000 LBS.
WALLEYE
MILLIONS OF POUNDS
20
18
16
14
12
10
8
6
4
2
0
1920
1940
1960
YEAR

FIGURE 52

TABLE 32

Average combined annual United States and Canadia
production for specified periods of major[1] commercial species of
(thousands of pounds)

Period	Sturgeon	No. Pike	Cisco	Sauger[4]	Whitefish	Blue Pike[6]	Walleye	Yellow perch	Smelt	Sheepshead	White bass[4]
1879-1909[3]	1,052	1,356	25,625	3,700	2,402	10,797[7]	--	2,791	--	1,061	611
1910-1919[3]	77	1,250	27,201	3,656	2,945	9,277	1,756	3,017	--	2,499	383
1920-1929[3]	39	77	14,126	2,437	1,675	11,292	1,577	5,356	--	2,367	360
1930-1934	39	62	764	1,943	2,094	14,623	2,113	12,382	--	2,381	447
1935-1939	31	29	1,070	1,414	2,696	18,526	3,515	6,444	--	3,359	655
1940-1944	22	37	283	878	4,058	13,517	3,779	3,869	--	3,624	553
1945-1949	25	21	8,067	567	4,701	12,509	5,807	4,245	--	3,965	701
1950-1954	14	12	475	354	2,297	13,535	7,566	6,784	890	3,492	3,485
1955-1959	14	14	128	21	749	10,078	10,267	19,540	4,345	4,020	5,092
1960-1964	4	2	8	1	19	3	1,484	20,219	13,508	5,770	4,111
Largest catch	5,187	2,873	48,823	6,181	7,098	26,788	15,405	28,954	11,495	6,566	9,451
Year of Largest catch	1885	1908	1918	1916	1949	1936	1956	1959	1960	1960	1954

[1] Species that have had an annual production greater than 1 million pounds.
[2] Species normally less than 1 million pounds (goldfish, bullheads, burbot).
[3] Average for years of record.
[4] U.S. catch only until 1952.
[5] Includes bullheads through 1951.
[6] Catches of walleye and blue pike combined through 1914.
[7] Probably composed of 8-9 million pounds of blue pike and the remainder walleye.

From "Report on Commercial Fisheries Resources of the Lake Erie Basin," U. S. Bureau of Commercial Fisheries, 1966.

TABLE 32

Average combined annual United States and Canadian
on for specified periods of major[1] commercial species of Lake Erie
(thousands of pounds)

/	White-fish	Blue Pike[6]	Wall-eye	Yellow perch	Smelt	Sheeps-head	White bass[4]	Sucker[4]	Channel catfish[5]	Carp	Other[2]	Total Production
00	2,402	10,797[7]	--	2,791	--	1,061	611	1,350	604	2,480	100	53,923
56	2,945	9,277	1,756	3,017	--	2,499	383	1,120	1,110	7,544	2,015	63,850
37	1,675	11,292	1,577	5,356	--	2,367	360	1,030	681	3,189	1,476	45,742
43	2,094	14,623	2,113	12,382	--	2,381	447	1,462	700	2,659	1,594	43,263
14	2,696	18,526	3,515	6,444	--	3,359	655	980	641	2,689	1,984	44,013
78	4,058	13,517	3,779	3,869	--	3,624	553	628	948	2,593	1,744	36,716
67	4,701	12,509	5,807	4,245	--	3,965	701	506	1,093	2,077	2,226	44,510
54	2,297	13,535	7,566	6,784	890	3,492	3,485	661	1,589	3,007	573	45,134
21	749	10,078	10,267	19,540	4,345	4,020	5,092	413	1,770	4,171	733	61,355
1	19	3	1,484	20,219	13,508	5,770	4,111	333	1,484	4,276	792	52,014
31	7,058	26,788	15,405	28,954	11,495	6,566	9,451	2,024	2,228	13,419	--	76,313
16	1949	1936	1956	1959	1960	1960	1954	1930	1917	1914	--	1915

duction greater than 1 million pounds.
n pounds (goldfish, bullheads, burbot).

mbined through 1914.
unds of blue pike and the remainder walleye.

Resources of the Lake Erie Basin,"
, 1966.

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TABLE 33

U. S. COMMERCIAL FISH CATCH STATISTICS
(Annual Averages in thousands of pounds)

	Cisco	Sau-ger	White-fish	Blue Pike	Wall-eye	Yellow Perch	Smelt	Sheeps-head	White Bass	Suck-er	Cat-fish	Carp	Other	Total	Canada	Total Catch
1955	34	15	375	7,648	5,795	2,408	*	1,614	2,931	256	1,947	3,308	465	26,796	30,285	57,080
1956	59	12	445	6,855	6,130	7,054	*	1,924	2,368	269	1,660	3,425	543	30,744	44,682	75,426
1957	23	7	754	3,981	5,035	8,593	2	3,795	1,424	328	1,554	3,768	442	29,706	37,105	66,811
1958	14	2	177	576	3,961	7,061	1	2,816	942	244	1,472	4,880	429	22,575	30,751	53,326
1959	16	1	46	32	1,168	9,348	15	4,608	818	249	1,429	4,015	238	22,433	31,597	54,030
1960	12	2	15	7	1,171	6,390	28	5,098	1,739	250	1,619	4,572	315	21,258	29,219	50,477
1961	6	*	6	2	805	3,694	16	5,764	2,192	330	1,626	4,698	424	19,563	35,698	55,261
1962	5	*	3	1	433	7,548	74	3,524	1,390	261	1,127	4,764	530	19,660	44,464	64,124
1963	1	*	6	*	800	5,822	306	4,126	1,153	224	1,090	3,338	372	17,238	34,233	51,471
1964	—	*	2.8	*	564	1,519	446	4,549	1,535	239	1,163	2,909	400	13,354	25,381	38,375
1965	1	*	6	*	438	3,157	3	4,086	1,110	1	990	3,191	542	13,525	35,096	48,621
1966[1]	*	*	2	*	163	3,262	8	2,058	1,151	140	710	2,773	248	10,515		

[1] Includes only Ohio catch.

The capability of Lake Erie to support fish, considered as a total population of all species, has apparently been maintained and may be increasing. This means that the habitat is changing in favor of such fish as carp, alewife, shad, sheepshead, etc. These are generally considered as indicators of general water quality degradation.

Massive adult and near-adult fish kills occur in Lake Erie and have occurred on various occasions for many years. These kills are not associated with the decline of desirable species. Species which have been susceptible to kills have commonly been perch, white bass, alewife, smelt, gizzard shad, and carp. Kills seem to be more common in the months of June and August. Occasionally during times of large commercial catches, the appearance of a local kill may be given by the discarding of fish from commercial fishing operations. Sometimes fish kills have been called natural die-off, but this does not appear to be a good explanation. At any rate, it does not appear that massive fish kills have had a measurable effect on any species in Lake Erie.

Doubtless the changing benthic fauna of Lake Erie have had an effect on the fish population because many fish are bottom feeders and prefer certain types for food. It is also true, however, that most fish will adapt themselves, at least up to a point, to the diet at hand. The total effect of changing food supply is not known, but it can be said that the effect has been detrimental to most desirable species and these desirable species are carnivorous types.

Desirable fish species, according to the Bureau of Commercial Fisheries, are experiencing difficulty in reproduction and this difficulty is responsible to a great degree for the decline of these species. The cause appears to be pollutional in silting of spawning areas and depletion of dissolved oxygen.

CHAPTER 5

LAKE ERIE BACTERIOLOGICAL CHARACTERISTICS

WATER BACTERIOLOGY

The U. S. Public Health Service conducted microbiological investigations of Lake Erie and its drainage basin in the spring, summer, and fall of 1963 and 1964 in order to determine present microbiological quality of the waters. Further objectives were to determine points of influx and extent of sewage and fecal contaminated waters and to aid in the evaluation of microbiological water quality criteria for major uses. The following table shows the groups measured and the frequency of measurement.

Groups used	Frequency
1. Total coliform, 35°C	
a. Membrane filter (MF)	all routine samples
b. MPN (most probable number)	selected samples
2. Fecal coliform, 44.5°C	
a. MF	all routine samples
b. E.C. (Escherichia coli.)	10-20% of all samples
c. MPN - E.C.	10% of all samples
3. Fecal streptococci, 35°C	
a. MF (Kenner, etc.)	all routine samples
4. Total bacterial count	
a. MF, 20°C	all lake and inshore samples
b. MF, 35°C	all lake and inshore samples
5. Enteric pathogens	
a. Salmonella, Shigella	Tributary & bathing beach samples
b. Enteroviruses	Tributary & bathing beach samples

All determinations were made in accordance with procedures set forth in Standard Methods for the Examination of Water and Wastewater, 11th Edition, 1960, or in accordance with those established through research at the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, and described in Recent Developments in Water Microbiology, 1964.

The coliform group is defined as consisting of aerobic and facultative anaerobic, gram-negative, non-sporeforming, rod-shaped bacteria which ferment lactose with gas formation within 48 hours at 35°C.

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The members of the coliform group are found in the feces of warm-blooded animals, including man; in the guts of cold-blooded animals, in soils, and on many plants. The presence of coliform bacteria derived from warm-blooded animal feces in a body of water is interpreted as indicative of the possibility of the presence of enteric pathogens. Increased densities of coliform bacteria found in water are related to the greater possibility of their association with enteric disease-producing groups found in the gut of ill persons.

The fecal coliform group is that part of the coliform group associated with fecal origin in warm-blooded animals. The purpose of the test is to separate the members of the coliform group into those of fecal and non-fecal origin. The test is based on the ability of coliform bacteria associated with warm-blooded animals to grow at 44.5°C ± 0.5°C and the failure of coliform bacteria from cold-blooded animals, plants, and soil to grow at that temperature.

The sanitary significance of the fecal coliform bacteria in a body of water is described (Public Health Service, 1963) as follows:

> "In untreated waters, the presence of fecal coliforms indicate recent and possibly dangerous pollution. In the absence of fecal coliforms, the presence of intermediate or aerogenes organisms suggests less recent pollution or runoff. Present information indicates that non-fecal subgroups tend to survive longer in water and resist chlorination more than E. coli."

High total coliform densities, accompanied by high fecal coliform densities, indicate the presence of human wastes and the possibility of human enteric pathogens capable of causing enteric infection and/or disease.

The fecal streptococcus group is any species of streptococcus commonly present in significant numbers in the fecal excreta of humans or other warm-blooded animals, rarely occurring in soil or in vegetation not contaminated with sewage. The Public Health Service (1963) states that:

> "The presence of fecal streptococci means that the fecal pollution is present in amounts no greater than originally present or in reduced amounts comparable to the combined effects of natural purification processes, for they do not multiply in water to produce overgrowths as sometimes occurs with the coliform groups."

Recent research studies (Geldreich et.al., 1964) indicate that when the ratio of fecal coliforms to fecal streptococci exceeds 2:1 the fecal bacteria have originated from domestic sewage, whereas ratios of 1:1 or less are indicative of wastes from warm-blooded animals other than man, such as stockyard and dairy animals.

The total bacterial count was determined after incubation at 35°C ± 0.5 for 24 hours ± 2 hours, and at 20°C ± 0.5 for 48 hours ± 3 hours. The method was used to determine an approximation of all viable bacterial populations able to produce colonies under the test procedures. The tests were used to provide information applicable to water quality evaluation and to give support to the significance of coliform test results.

Enteric pathogens were detected according to methods described by Edwards and Ewing (1962). The resulting data were used to demonstrate the existence of enteric pathogenic bacteria such as Salmonella and Shigella in streams draining into the Lake Erie basin. The data were correlated with associated bacteriological data.

The presence of enteric pathogenic bacteria in a body of water indicates a potential health hazard.

Enterovirus studies were conducted by Dr. Norman Clark, of the Robert A. Taft Sanitary Engineering Center. Enteroviruses such as infectious hepatitis, polio, coxsackle, and echo viruses and adenoviruses may be found in large quantities in the feces of infected individuals, and in sewage. Infections with these agents are widespread in the normal population especially during the summer and early fall. Presence of these viruses in a body of water is indicative of the presence of fecal matter containing them.

WESTERN BASIN

Bacterial water quality in western Lake Erie in offshore waters was measured in 308 samples collected in 1963 and 1964 from the fixed depths of surface, 5, 10, and 20 meters, depth permitting. In order to achieve a more valid picture of bacterial distribution, it was necessary to separate the values according to "surface" and "lowermost" conditions. Samples collected from mid-depth and deep waters revealed a substantial reduction in bacterial densities from those of the surface, and this was true in all three lake basins. A consistent and significant increase in bacterial densities at all depths was found at the inflow areas of major tributaries.

Median total coliform densities for surface and lowermost samples are shown in Figure 53 and Figure 54, respectively. Surface coliform concentrations are expressed in six ranges: less than 1, 1 to 10, 10 to 100, 100 to 500, 500 to 1,000, and 1,000 to 2,400 organisms per 100 ml of sample. Lowermost coliform values include just the first five ranges.

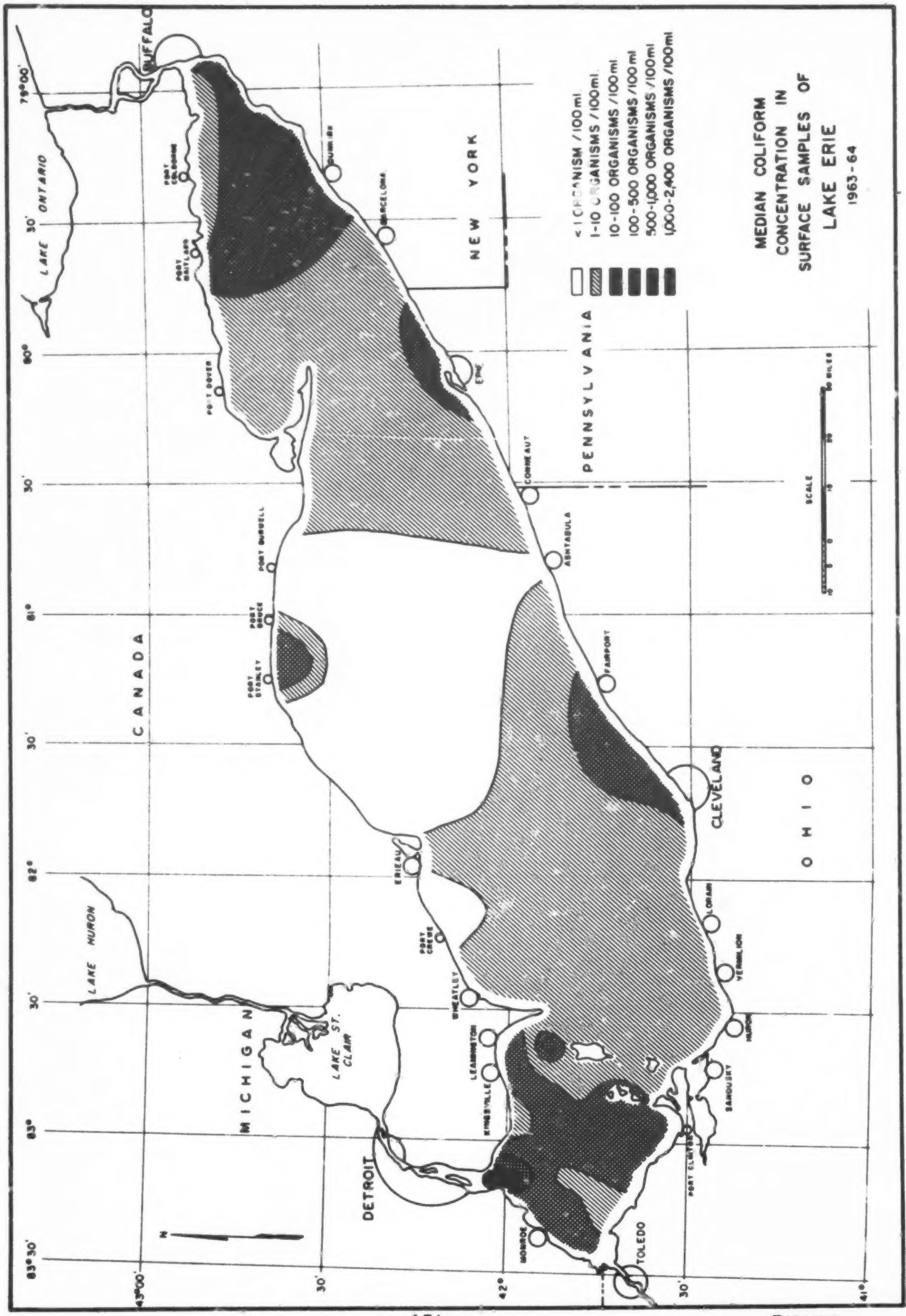
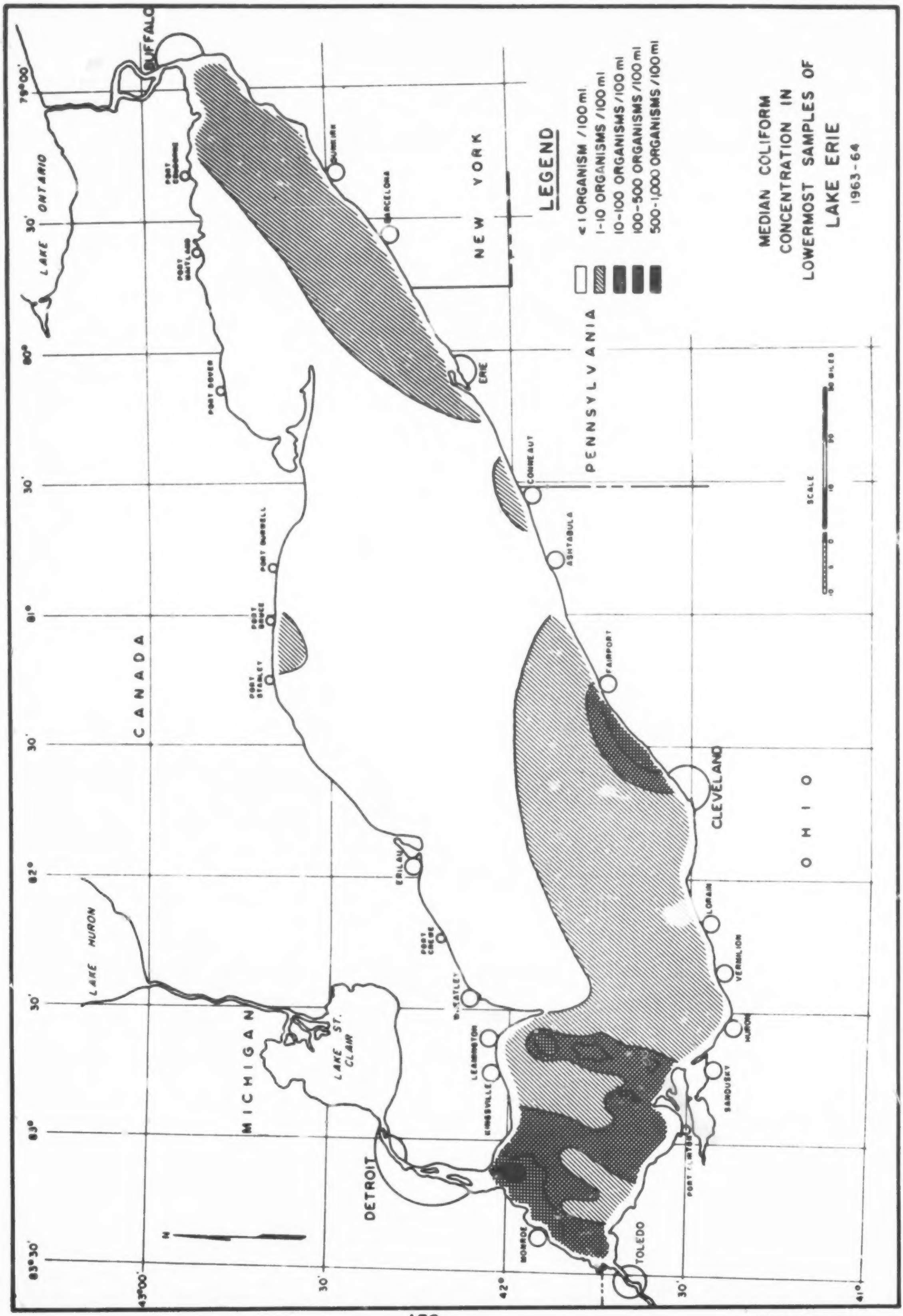
MEDIAN COLIFORM
CONCENTRATION IN
SURFACE SAMPLES OF
LAKE ERIE
1963-64
< 1 ORGANISM / 100ml
1-10 ORGANISMS / 100ml
10-100 ORGANISMS / 100ml
100-500 ORGANISMS / 100ml
500-1,000 ORGANISMS / 100ml
1,000-2,400 ORGANISMS / 100ml
SCALE
CANADA
MICHIGAN
OHIO
PENNSYLVANIA
NEW YORK
LAKE ONTARIO
LAKE HURON
LAKE ST. CLAIR
BUFFALO
DUNKIRK
BARCELONA
ERIE
CONNEAUT
ASHTABULA
FAIRPORT
CLEVELAND
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
TOLEDO
MONROE
DETROIT
KINGSVILLE
LEAMINGTON
WHEATLEY
PORT COLBORNE
PORT MAITLAND
PORT DOVER
PORT BURWELL
PORT BRUCE
PORT STANLEY
ERIEAU
79°00'
30'
80°
81°
82°
83°
83°30'
43°00'
42°
41°

FIGURE 53



LEGEND
< 1 ORGANISM /100 ml
1-10 ORGANISMS /100 ml
10-100 ORGANISMS /100 ml
100-500 ORGANISMS /100 ml
500-1,000 ORGANISMS /100 ml
SCALE
CANADA
MICHIGAN
NEW YORK
PENNSYLVANIA
OHIO
LAKE ONTARIO
LAKE HURON
LAKE ST. CLAIR
BUFFALO
DUNKIRK
BARCELONA
ERIE
CONNEAUT
ASHTABULA
FAIRPORT
CLEVELAND
LORAIN
VERMILION
HURON
SANDUSKY
PORT CLINTON
TOLEDO
MONROE
DETROIT
KINGSVILLE
LEAMINGTON
WHEATLEY
PORT CREWE
ERIEAU
PORT STANLEY
PORT BRUCE
PORT BURWELL
PORT DOVER
PORT MAITLAND
PORT COLBORNE
79°00'
30'
80°
30'
81°
30'
82°
30'
83°
83°30'
43°00'
30'
42°
30'
41°

MEDIAN COLIFORM CONCENTRATION IN LOWERMOST SAMPLES OF LAKE ERIE 1963-64

FIGURE 54

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It is evident that extensive bacterial pollution exists at the mouth of the Detroit River. Off the mouth, median coliform values of 1,000 to 2,400 organisms per ml were found in the surface samples and 500 to 1,000 per ml in the lowermost samples. Fecal coliform densities ranged from 18 to 54 percent of the total coliforms. Numbers of fecal streptococci were less than either fecal or total coliforms. The ratio of fecal coliform to fecal streptococcus exceeded 2:1 at all depths, indicating the presence of human wastes derived from domestic sewage. Total bacterial counts near the Detroit River mouth exceeded 20,000 per ml in the maximum values, indicating the presence of a large amount of organic matter.

From this zone southward to east of Stony Point, Michigan, both surface and subsurface samples showed median total coliform concentrations between 500 and 1,000 organisms per 100 ml, exceeding this range in maximum values. Fecal streptococci densities were below 20 organisms per 100 ml. The ratio of fecal coliform to fecal streptococcus averaged 16:1, indicating the presence of domestic sewage. Total bacterial densities at 20°C and 35°C ranged from 2,700 to 59,000 organisms per ml, with slightly higher values at 20°C.

A zone of median coliform densities of 100 to 500 per ml with three to six percent fecal coliform, along the west shore, was shown only in the lowermost samples, with surface samples showing median counts of less than 100 per 100 ml. It appeared that the Raisin River was supplying polluted water. Similar total coliform densities were found in waters north of Pelee Island with five to ten percent fecal coliform. Fecal streptococci showed a median of 32 organisms per 100 ml. The ratio of fecal coliform to fecal streptococcus did not exceed 2:1, indicating a source from warm-blooded animals other than man.

A zone of median coliform densities of 10 to 100 per 100 ml in surface samples radiated south, southwest, and southeast from the Detroit River mouth area, extending into the southern island group and to the Canadian shore in the Pigeon Bay area. Lowermost samples were similar in area but slightly different in zonal shape. Other areas showed a median total coliform range of 1 to 10 organisms per 100 ml. Fecal streptococci median values were less than 20 organisms per 100 ml in areas with less than 100 coliforms per 100 ml.

CENTRAL BASIN

Total coliforms, fecal coliforms, fecal streptococci, and total bacterial counts at 20°C and 35°C were made on 1,228 samples from central Lake Erie. Samples were taken at the surface and at 5, 10, 20, 30, 40, and 50 meters, depth permitting. Samples taken at mid-depth and below are referred to as "lowermost" samples.

Samples collected from surface waters showed higher bacterial densities than the lowermost samples except for an area around the mouth of the Chagrin River (see Figures 53 and 54).

The highest median total coliform values in the central basin, 100 to 500 organisms per 100 ml, were shown in deep water samples in the offshore area near the Chagrin River. Maximum values reached 3,000 organisms per 100 ml. Fecal coliforms ranged from 4 to 14 percent of the total coliform densities. The ratio of fecal coliforms to fecal streptococci ranged from 6:1 to 15:1, indicating pollution by domestic sewage.

Median total coliform values of 10 to 100 organisms per 100 ml were found in surface samples from two offshore areas. One area was around Cleveland, extending approximately 20 miles north and 30 miles northeast (Figure 53). Maximum coliform values for this area exceeded 5,000 organisms per 100 ml. Median total coliform densities in lowermost samples (Figure 54) ranged from 10 to 100 per ml, but did not exceed 5,000 per 100 ml. Median fecal coliform densities ranged from 4 to 70 percent of the total, indicating the presence of pollution from domestic sources. Fecal streptococcus densities exceeded 20 organisms per 100 ml in the maximum values. The ratio of fecal coliforms to fecal streptococci was 2:1 or greater at all depths, indicating the presence of human wastes derived from domestic sewage. Total bacterial counts in this area at 20° and 35°C at all depths ranged from 91 to 740 per ml in median values and from 570 to 73,000 per ml in maximum values. The pollution effect of the Cuyahoga River was evident. The gross pollution from the Cleveland area was apparently kept close to the United States shore and followed the shoreline east of Cleveland.

The second area of median total coliform densities of 10 to 100 organisms per 100 ml was located along the Canadian shore near Port Stanley and was shown in surface waters only (Figure 53).

Median total coliform values of 1 to 10 organisms per 100 ml were found in a major portion of Central Lake Erie offshore surface and lowermost waters as shown in Figures 53 and 54. Maximum coliform densities were below 1,000 organisms per 100 ml. The ratio of fecal coliform to fecal streptococcus was 1:1 or less. Total bacterial counts at 20° and 35°C ranged from 5 to 110 per ml in median values at all depths.

EASTERN BASIN

Bacterial values were also measured in 255 samples of eastern basin water. As in the other basins, the lowermost samples showed lesser densities than surface samples.

An area of median total coliform densities of 10 to 100 organisms

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per 100 ml in surface samples was located around Presque Isle, Pennsylvania. Maximum values were 3,400 coliforms per 100 ml, fecal coliforms of 44 percent, and fecal streptococcus of 1,200 organisms per 100 ml. In general, the coliform population from the Presque Isle area was diffused in a fan-like pattern and dissipated in a distance of approximately five miles from the shore. High coliform densities in maximum values accompanied by high fecal coliform values were indications of domestic sewage pollution.

Another major zone with median total coliform values in the surface samples of 10 to 100 organisms per 100 ml extended over most of the eastern half of the basin (Figure 53). The lowermost samples had a median range of 1 to 10 coliform bacteria per 100 ml decreasing to less than 1 north of the international boundary (Figure 54). Median fecal coliform and fecal streptococcus values ranged from less than 1 to 12 organisms per 100 ml. Total bacterial counts ranged from 60 to 420 at 20°C and from 10 to 50 per ml at 35°C in median values.

LAKE ERIE HARBORS (SOUTH SHORE)

Evaluation of the quality of these waters was made in 1964 from the examination of water samples collected from representative sampling points at surface and mid-depth levels. Bacterial pollution was measured in terms of total coliforms, fecal coliforms, fecal streptococci, and enteric pathogens.

Gross bacterial pollution was demonstrated at the mouths of Ottawa, Maumee, Portage, Black, Rocky, Cuyahoga, Chagrin, Grand, Ashtabula, and Buffalo Rivers.

OTTAWA RIVER AND MAUMEE RIVER

A median total coliform value of 90,000 organisms per 100 ml was observed in the Ottawa River which empties into Maumee Bay. The mouth of the Maumee River contained a median of 190,000 coliform organisms per 100 ml. High median fecal coliform (125,000/100 ml) and fecal streptococcus (1,000/100 ml) densities were accompanied by enteric pathogenic bacteria. Six species of Salmonella were isolated in the Ottawa and Maumee Rivers. The peak incidence of Salmonella occurred from January through April 1964.

Bacterial pollution in the Toledo Harbor became well diluted within 2 to 4 miles lakeward of the mouth where median coliform values ranged from 100 to 1,000 organisms per 100 ml, with 10 to 50 percent fecal coliforms.

PORTAGE RIVER

Results from Portage River, at its mouth, showed a median coliform level of 17,500 organisms per 100 ml, with 14 percent fecal coliform. The median fecal streptococci count was 1,100 organisms per 100 ml. *Salmonella* organisms were found during the spring survey.

SANDUSKY HARBOR

Sandusky Harbor median total coliform densities ranged from 800 to 6,000 organisms per 100 ml with correspondingly high fecal coliform results. The median total coliform value of 6,000 organisms per 100 ml with a fecal coliform to fecal streptococcus ratio of 18:1 was demonstrated at a sampling point east of the Sandusky sewage treatment plant. From the tip of Cedar Point lakeward, median total coliform values were less than 1,000 per 100 ml. In the Sandusky River highest bacterial densities were found near the Fremont treatment plant and the presence of *Salmonella* was revealed.

LORAIN HARBOR-BLACK RIVER

Results from Lorain outer harbor, lakeward of the river mouth showed a median total coliform range of 100 to 9,000 organisms per 100 ml with 16 to 53 percent fecal coliform. Fecal streptococci median values ranged from 19 to 340 organisms per 100 ml. Median total bacterial counts at 20°C and 35°C ranged from 600 to 150,000 organisms per ml. The coliform numbers in the outer harbor correspond to those in the Black River above the Lorain sewage treatment plant.

The median total coliform counts at the mouth of the Black River ranged from 6,900 to 28,000, while maximum values exceeded 2,000,000 organisms per 100 ml. Median fecal coliform densities ranged from 2 to 64 percent of the total, and median fecal streptococci showed values of 200 to 500 organisms per 100 ml. *Salmonella* organisms were found just above the mouth of the river.

The outflow of the Black River was traced, bacteriologically, into Lake Erie approximately one mile to the north and east. Stations west of the breakwall showed median total coliform values of less than 1,000 organisms per 100 ml.

ROCKY AND CUYAHOGA RIVERS - CLEVELAND HARBOR

Median coliform densities greater than 5,000 organisms per 100 ml were observed at the mouths of Rocky and Cuyahoga Rivers. Maximum coliform densities ranged from 560,000 to 1,200,000 organisms per 100 ml. Fecal coliform population ranged from 8 to 10 percent of the total coliform, and fecal streptococci showed values from 900 to 49,000 organisms per 100 ml. Fourteen *Salmonella* serotypes were isolated from the mouth of Cuyahoga River and ten from the mouth of Rocky River. These findings are attributed to the gross pollution of human wastes entering these streams. The water leaving Rocky and Cuyanoga Rivers carries bacterial pollution into Lake Erie. Results obtained from sampling points north and east of the Rocky River, approximately one-half mile from the shore, showed median coliform densities in excess of 1,000 organisms per 100 ml, reaching a level of 86,000 in the maximum values. The total coliform results inside and immediately outside of the breakwall in Cleveland Harbor showed median coliform values from 3,300 to 10,000 organisms per 100 ml with 9 to 30 percent fecal coliform. The ratio of fecal coliform to fecal streptococcus ranged from 5:1 to 30:1. Maximum total coliform values showed a level of 520,000 organisms per 100 ml north of the breakwall. The maximum total bacterial counts at 20°C and 35°C inside and outside of the breakwall ranged from 13,000 to 660,000 organisms per ml. These results indicate that the water inside and immediately outside of the breakwall is polluted to the extent that it cannot safely be used for municipal water source, recreational, or for other uses involving body contact. A marked decrease in total coliform and an increase in percentage of fecal coliform organisms in the harbor was noted during the study.

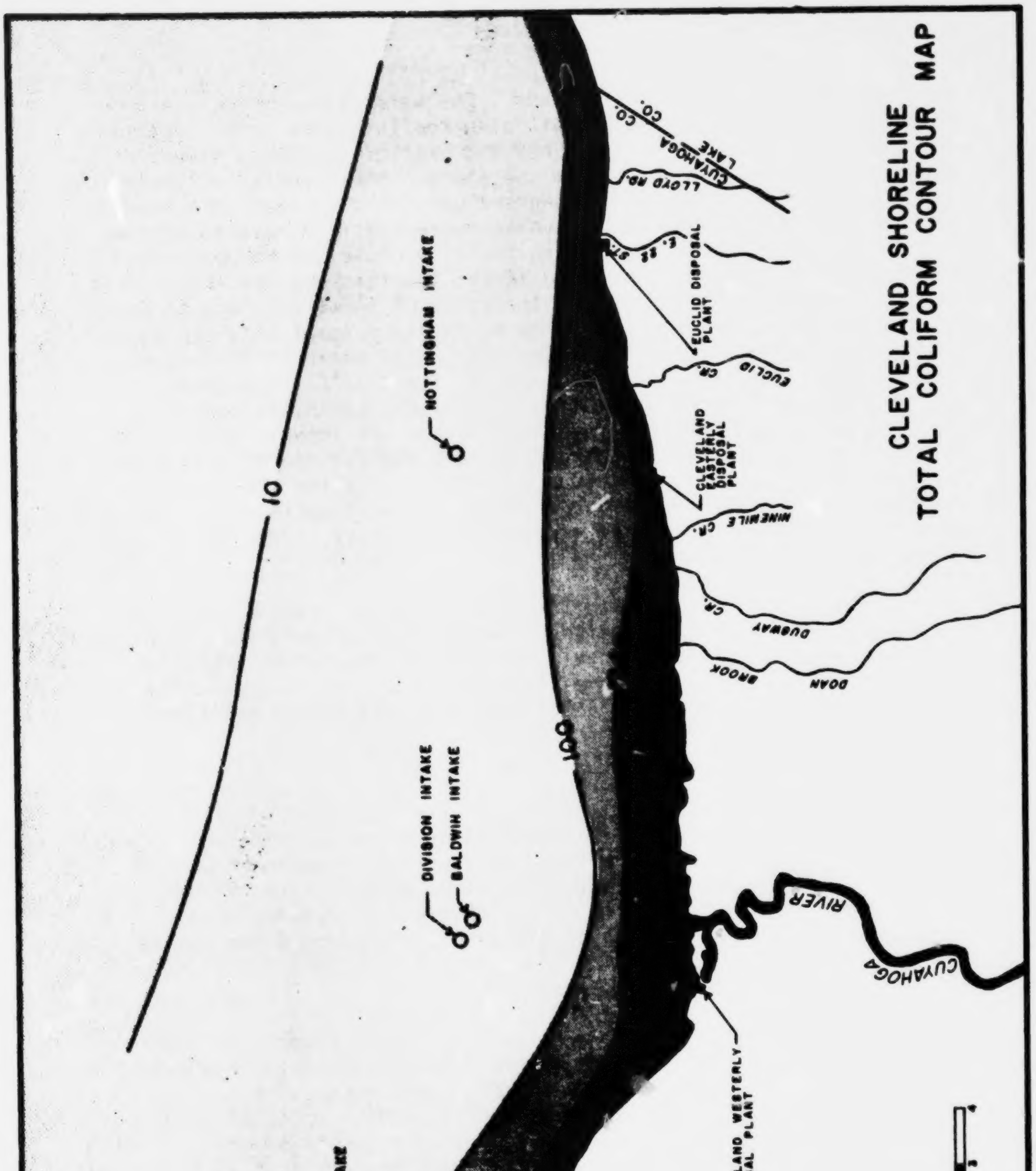
The gross bacterial pollution from these two tributaries is lost within a distance of 2 to 3 miles into the lake (Figure 55). The pollution tends to flow northeast and east of the harbor, becoming diffused and diluted as it moves into the lake. It is apparently forced close to the United States shore and follows the shoreline east of Cleveland.

CHAGRIN RIVER

Median coliform density in the Chagrin River at its mouth showed a level of 7,300 organisms per 100 ml, reaching a maximum of 90,000, with 23 to 50 percent fecal coliform. The ratio of fecal streptococcus ranged from 2:1 to 3:1. Three species of Salmonella were isolated from river samples indicating pollution from human wastes.

GRAND RIVER - FAIRPORT HARBOR

The highest bacterial densities in the Grand River were observed 2.3 miles above the mouth. The median total coliform value was 15,000 organisms per 100 ml with 40 percent fecal coliform. The maximum coliform was 340,000 organisms per 100 ml. The median ratio of fecal coliform to fecal streptococcus was 8:1. Two species of Salmonella were found at this sampling point and represented the presence of pollution from domestic fecal sources. Median coliform densities of 1,400 organisms per 100 ml with 7 percent fecal coliform were observed just above the river mouth. The maximum total coliform densities reached a level of 8,000 organisms per 100 ml. The median ratio of fecal coliform to fecal streptococcus was 1:1.


10
100
NOTTINGHAM INTAKE
DIVISION INTAKE
BALDWIN INTAKE
CROWN INTAKE
ROCKY RIVER DISPOSAL PLANT
LAKEWOOD DISPOSAL PLANT
ROCKY RIVER
CLEVELAND WESTERLY DISPOSAL PLANT
CUYAHOGA RIVER
DOAN BROOK
DUGWAY CR.
NINEMILE CR.
CLEVELAND EASTERLY DISPOSAL PLANT
EUCLID CR.
EUCLID DISPOSAL PLANT
E. 88 ST.
LLOYD RD.
CUYAHOGA CO.
LAKE CO.
SCALE IN MILES
1
0
1
2
3
4

CLEVELAND SHORELINE
TOTAL COLIFORM CONTOUR MAP

NOTE:
BASED ON 1964 DATA-MEDIAN
TOTAL COLIFORM CONCENTRATIONS
IN ORGANISMS PER 100ml.

FIGURE 55

In the Fairport Harbor, inside the breakwalls and beyond the river mouth, median total coliform densities ranged from 15 to 540 organisms per 100 ml with 4 to 67 percent fecal coliform. The median fecal streptococci count exceeded the fecal coliform count at one station. A count of 3,200 organisms per 100 ml was observed during the study. These findings indicate pollution from sources other than man. A maximum total coliform density encountered was 34,000 organisms per 100 ml. Median total bacterial counts at 20°C and 35°C ranged from 280 to 6,700 organisms per ml, reaching the highest level of 710,000 organisms per ml.

ASHTABULA RIVER

Median values of total coliform levels in the Ashtabula River at its mouth, and in the Ashtabula Harbor, inside the breakwall, exceeded 1,000 organisms per 100 ml. A range of 17,000 to 64,000 coliform organisms per 100 ml was demonstrated in the maximum values. Median fecal coliform densities ranged from 11 to 28 percent of the total coliform at the mouth of the Ashtabula River and from 6 to 40 percent in the Ashtabula Harbor inside the breakwall. The ratio of fecal coliform to fecal streptococcus was as high as 176:1 in the harbor. Salmonella heidelberg was isolated at a sampling point 0.7 miles upstream. The waters in Ashtabula River, at its mouth, and in the Ashtabula Harbor, inside of the breakwall, were found to be in a continual state of gross pollution in terms of microbiological parameters. Bacterial quality of these waters were unacceptable for recreational purposes and at times for municipal or other uses. Water west of the breakwall was of good bacterial quality. Waters north and northeast of the breakwall showed total coliform densities of 2,700 to 3,300 organisms per 100 ml in the maximum values.

ERIE HARBOR - PRESQUE ISLE

Study of the microbiological results of sampling in the Presque Isle area reveals low coliform densities on the west side of the peninsula near the shore. The results from sampling stations located north and northeast of the isle indicate a substantial increase in coliform densities in the maximum values. A corresponding increase in coliform values was observed in Erie Harbor. Median total coliform values of 2,100 to 17,000 organisms per 100 ml were demonstrated in samples collected from Erie Harbor stations located near Mill Creek and in the ship channel. Maximum total coliform in this area reached a value of 520,000 organisms per 100 ml. Median fecal coliform densities in waters north and east of Presque Isle ranged from 3 to 12 percent of the total coliform densities and fecal streptococci counts averaged from 1 to 10 organisms per 100 ml. The ratio of fecal coliform to fecal streptococci ranged from 2:1 to 5:1 in the median values. The source of this pollution is probably Mill Creek. Salmonella organisms were isolated from 80 percent of the samples collected in both Mill Creek and the harbor. The same organisms were found in Erie's sewage. Generally, the water quality at the stations west of Presque Isle was of satisfactory quality for swimming purposes. The water quality north and east of Presque Isle varied considerably. The maximum total coliform values of 2,800 to 15,000 organisms per 100 ml indicated the pollution entered the lake intermittently, constituting a health hazard in the immediate vicinity along the eastern shore.

BUFFALO RIVER

The Buffalo River showed a median total coliform concentration of 25,000 organisms per 100 ml near its mouth with 14 percent fecal coliform. Salmonella was isolated from this area. The Buffalo River is grossly polluted bacterially.

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CHAIRMAN STEIN: Are there any questions or comments?

MR. LYON: Mr. Chairman, I think this is a good report. There is one minor point that ought to be clarified for the record.

In summary, the beaches -- I think one through ten -- on Presque Isle are shown as one beach, and they are actually ten separate beaches and they are separately sampled and we have separate data for all of those beaches, and the fact is we do have ten -- in fact eleven -- but you have listed one through ten as one beach, and it is ten beaches.

MR. HARLOW: I knew you were going to ask that question, Walter, or clarify that point.

CHAIRMAN STEIN: Any further questions or comments?

MR. METZLER: I think as far as New York is concerned we will have some specific comments in the New York statement. Perhaps, it will be just as well to handle it at that time.

On this matter of one beach versus ten, I would like to know: how did you identify what was a public beach and what wasn't? How did you count these?

MR. HARLOW: It wasn't easy, Mr. Metzler.

MR. METZLER: Of course it wasn't.

MR. HARLOW: Because you run into the problem, when you try to evaluate satisfactory bathing beach water quality anywhere as to what is a beach and what isn't a beach. We considered, of course, whether people swim there and whether it was open to the public. We also considered whether county departments of health considered whether it was a bathing beach or not, and whether they tested water quality. A number of these factors went into it and I recognize that there is a certain amount of judgment applied here to decide what is a bathing beach and what is not a bathing beach.

We tried to emphasize, of course, I think, in the report the beaches that are used to a great extent by the public.

MR. METZLER: Did you then check this with some of our -- well, either our regional office in New York or the local health departments to see what they thought were public beaches for which permit might be required, and what was not a public beach?

MR. HARLOW: We discussed it with the various offices around the lake.

Another problem we run into is different States interpret them different ways, and we tried to be uniform in our interpretation.

MR. METZLER: Well, the problem is a very difficult one because I recall going all down that lakefront in a helicopter on a holiday and the whole lake or the beach in New York State was being used. There was hardly a mile that somebody wasn't in the water. So you can take that position; but it seems to me if you start trying to list the beaches that are satisfactory and unsatisfactory, then you almost need to take whatever the local or the State authorities have identified as a beach, subject to permit.

MR. HARLOW: I think one of the ones that I know I mulled around in my mind whether it was a beach or not was Times Beach. I don't know whether you are aware of that or not, but it is up at the mouth of the Buffalo River. It is not a very good spot for a beach, but the county department does sample it for coliform bacteria and we might have bathing water quality standards there.

MR. METZLER: Well, it seems to me you determine it on the basis of whether the Erie County Health Department issues a permit for it. If they issue a permit, it is a public beach; if they don't it is not.

MR. HARLOW: By the way, I think you might be interested to know that in regard to New York especially, we had comments from Mr. Seebald, I believe, and it may have been your office -- I don't quite recall -- on our original evaluations of the New York bathing beaches and there were some changes.

CHAIRMAN STEIN: Any further comments or questions?

If not, thank you very much.

MR. POSTON: As the next part of our presentation, I would like to ask Col. Wright, District Engineer, who is from the Buffalo office, who is in charge of the pilot dredging program to make his presentation at this time.

COL. WRIGHT: Thank you, Mr. Poston.

MR. POSTON: Would you proceed?

COL. WRIGHT: Yes, sir.

Mr. Chairman and gentlemen. I am Colonel Amos L. Wright, District Engineer, U.S. Army Engineer District, Buffalo. Today I am representing Brigadier General Robert M. Tarbox, Division Engineer of North Central Division, Corps of Engineers.

The United States Army Corps of Engineers appreciates the opportunity to present at this meeting information on our program to identify the pollution problems associated with the disposal of dredgings, and to develop procedures for insuring that State water standards are met. We believe it will be helpful in your consideration of the progress made since the Enforcement Conference of 1965 to improve and preserve the quality of the Lake Erie waters. The information is in two parts:

a. A brief narrative of the Corps' approach to identify the problem and to determine solutions that are in the best public interest; and

b. Our program of actions during the transition period, prior to determination of long-term solutions.

Shipping and Development:

To the American economy, transportation of commodities on the Great Lakes is a most important use of this great natural resource. There have been tremendous population growth and intensive industrial developments along the shores of Lake Erie, in part because of low-cost water transportation. Both have contributed to a serious pollution problem which, in some localities, impairs the aesthetics and recreational aspects of the water resource, threatens its utility as a source of water supply, and pollutes the materials which we must dredge in our harbor maintenance.

Maintenance Dredging:

The need to dredge arises because of the location of harbors on the Great Lakes, predominantly at the mouths of rivers flowing into the lakes.

In general, although not entirely, for more than forty years, we have placed the dredged material in authorized disposal areas in deep-water areas of the lakes. The areas were selected so as to be remote from water intakes and swimming beaches. During this time there is no history of contamination of beaches or water supply intakes attributable to lake disposal of dredgings. Now, I should make it clear that not all of the material to be dredged is polluted. At the Lake Erie ports tested by FWPCA, it appears that there are several areas where the material to be dredged is suitable for disposal in the lake.

The Problem:

Immediately after the Lake Erie Enforcement Conference in 1965, we investigated the feasibility of alternate disposal areas for a number of the Great Lakes Harbors. First, we looked at the possibility of using upland diked disposal areas. However, one does not have to look at more than a city map of any of the ports which have grown and thrived with the commerce resulting from our navigation projects to realize that unused land above water on which dredge spoil can be placed just is not available, in most cases, within a reasonable distance of the harbor and channel which must be maintained each year. And in most ports where there is intensive land use, additional filled areas of the type that dredged material would provide, are not desired by local interests. In considering the use of more distant land disposal areas, the costs of rehandling the dredged materials and transporting them rapidly drive the costs of maintenance sky high.

So, instead of trying to find upland areas, we took a look at how we could dispose of large quantities of dredge spoil in the water along shore, alongside of the breakwater in or near the harbor, or in shallow water areas of a bay. And, let me explain, gentlemen, that when I refer to "large quantities of dredge spoil," I am talking about quantities like 1,205,000 cubic yards which have to be taken from Outer Harbor and Cuyahoga River at Cleveland each year. To give you an idea of the size of the problem, that amount would cover a city block of Cleveland about 150 feet deep.

Our investigation -- back in 1966 -- indicated that, at most ports where the bottom material is polluted, there are possibilities for the use of diked disposal areas in the water. When the areas are filled in they might have some use. However, we estimated that the cost of constructing dikes to hold about ten years of dredging spoil, plus the increased costs of handling the material, would substantially increase the cost of harbor maintenance. The increase in cost varied considerably from harbor to harbor, but in general the net cost per cubic yard of maintenance dredging would be increased from two to five times.

This raised a question concerning the responsibilities of local interests to provide the diked disposal areas at local cost. Congress authorized many of these lake harbors to be constructed with the provision that materials dredged in the annual maintenance of these harbors would be placed in lake disposal areas. Open lake disposal was specified in almost all of the authorizing documents for the Great Lakes harbors before the days of the Water Pollution Control Act and related legislation.

Of course, this was because of the distinct economic advantage of lake disposal. In fact, if the economics of the justification for some of the projects had been based on use of other more expensive methods, some Lake Erie ports would not have been economically justified, and thus would not be in existence today. It is the current United States policy, however, where land disposal is required, for local interests to provide the diked disposal areas without cost to the Federal Government as an item of local cooperation.

The Pilot Program:

Still back in 1966, the Bureau of the Budget expressed the view that, before the taxpayers were requested to carry the burden of additional harbor

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maintenance cost, there should be further study of alternatives and further consideration of the public benefits of using alternative methods of dredgings disposal. Therefore, the Bureau requested that we and the FWPCA jointly conduct a pilot study of the problem. We were asked to study alternate means of disposing of dredged material, the pollution effects of the alternates and the costs. The FWPCA was asked to assist us in determining the effects and to identify the benefits that would be gained from the various alternatives.

In August 1966 we received $1 million to begin the study, and we were granted an additional $5 million in fiscal year 1968 to continue it. We expect to receive sufficient funds to complete the study in fiscal year 1969.

Early in 1967 we initiated our Pilot Program for Disposal of Dredgings from Great Lakes Harbors. Its objective is to develop the most economical methods for management of whatever pollution problems may result from dredging operations on the Great Lakes.

The Federal Water Pollution Control Administration is participating in the program by sampling, testing and analyzing the materials to be dredged and the waters surrounding them, as well as by participating in discussions of various methods under study. The Fish and

Wildlife Service of the Department of the Interior and the Public Health Service of the Department of Health, Education, and Welfare are also advising us.

The Corps has engaged the services of a Board of five consultants to assist us in the Pilot Program. Eight localities on the Great Lakes have been selected for the Pilot Program. These are: Great Sodus Bay on Lake Ontario; Buffalo, Cleveland, Toledo and River Rouge at Detroit on Lake Erie; Calumet Harbor and River, Indiana Harbor and Green Bay on Lake Michigan.

They were selected for two basic reasons: One, to test the effectiveness and compare costs of different types of disposal areas, structures, methods of handling the dredged material, and methods of treating any effluent from the disposal areas; and, two, to obtain this data at various representative harbors, with the degree of pollution varying from heavy to negligible.

Great Sodus Bay is a harbor with no discernible pollution problem. The others are considered to be polluted to various degrees. This slide shows the harbor at Great Sodus Bay

... Slide ...

To mention a few examples of methods under investigation:

... Slide ...

Col. Amos L. Wright

This slide shows the enclosed area we have built at Buffalo; there we are looking at the suitability of slag as a material for constructing dikes for a disposal area where the dredged spoil from the Buffalo River is placed within the enclosure in different ways.

... Slide ...

This is a slide of our experimental area at Cleveland; the dikes are made of crushed rock with a filter blanket. We are experimenting with two different methods of placing spoil from the Cuyahoga River in the area, and also filtering the water in the area to return it to the harbor.

... Slide ...

Here we have a picture of the diked disposal area in Maumee Bay at Toledo.

... Slide ...

This slide shows our area in the River Rouge at Detroit with a dredge tied up and pumping out through the pipeline leading to the discharge area.

At a number of locations we will test various methods of treating the effluent from the disposal operation. We are also investigating the feasibility of disposal in pits, mines and other areas away from the lake.

An important part of the Pilot Program consists of sampling water and bottom sediments at the dredging areas and in the vicinity of the alternate disposal areas and conducting various tests on the samples. The samples are being taken before, during and after the dredging operations.

While it is too early to draw any conclusions, we have found thus far that it is not too difficult to estimate costs of building structures, transporting and handling the spoil. But it is very difficult to measure the benefits of ceasing to place spoil in the open lake, especially when we cannot discern any change in water quality after dumping, and it is extremely difficult to determine the effect on living things in the vicinity.

We are working to complete our investigations and to render a report by the end of December 1968. In our report, we will present our recommendations on alternate methods of disposing of and treating polluted dredged materials, including the economic implications of any significant changes in maintenance costs. We contemplate presenting recommendations for each individual harbor that has been designated by the FWPCA as polluted. We will include recommendations on any cost sharing required of local interests. We will include our recommendations for any legislation required to carry out the alternate methods of disposing and of cost sharing.

Local Cooperation:

I emphasize local interest participation because some people seem to feel that the disposal of dredgings from navigation channels is solely a Corps of Engineers problem which the Corps can solve simply by putting the dredgings on land rather than in the authorized lake disposal areas. However, while the Congress has assigned to the Corps the work of providing and maintaining navigation depths at authorized river and harbor projects, the current congressional policy in connection with such projects has been that, where they are needed, disposal areas and retaining dikes or bulkheads will be provided by local interests at local expense as a part of the local cooperation required for the projects.

Of additional concern to local industry and commerce using Great Lakes harbors, is the necessity to dispose of materials dredged from private and public ships and alongside of docks, outside of the Federal channel. It is the responsibility of the owner to get this done and to pay for it. And I might emphasize that the owner must make every effort to find suitable areas other than in the lake to dispose of the spoil.

With reference to Congressman Ashley's remarks this morning, since the agreement went into effect last year with the Department of Interior, no permit has been issued to any private interest wishing to dispose of materials in the lake in which items of pollutants have been found.

Actions by the Corps:

At this point, it is appropriate that I set forth the various actions the Corps of Engineers is taking in disposal of dredged material:

1. Under the Pilot Program, alternate methods and areas for disposal of dredged material containing pollutants were used during the calendar year 1967 dredging program at six localities: Buffalo, Toledo, River Rouge at Detroit, Indiana Harbor, Calument Harbor and Green Bay. This year we added Cleveland to this list on a pilot scale. Thus at four of the harbors on Lake Erie that contribute most of the dredge spoil, a goodly portion is being placed in enclosed areas at this time.

Again, here, parenthetically I might remark that the figures given by Congressman Ashley were misleading. He used total figures which we provided him, but because of the lesser amount of material to be dredged in Toledo, when you add up everything, there is actually less dredging containing polluted material going into the lake in 1968 than there was in 1967, contrary to the impression that he left.

2. In addition to the Pilot Program localities, arrangements are being made for the use of alternate disposal areas at Monroe Harbor on Lake Erie. A land disposal site has been provided by the Port Authority and hopefully the diking will be completed to permit use of the area in 1968.

3. Each district engineer or his executive assistant has visited local authorities at every port where the FWPCA has reported that the material to be removed by dredging contains pollutants. We informed them of the extent of the problem and of the possible requirement for the use of suitable alternate areas and methods of disposal of polluted dredged materials.

Program for the Rest of This Year - 1968:

While, at this time, we are still developing long-term solutions for disposal of dredgings from polluted harbor areas, interim solutions have been and will be necessary. Our program for the remainder of calendar year 1968 dredging is as follows:

1. At polluted harbors, alternate disposal areas are being used during 1968 where arrangements can be made for suitable areas.

2. Ports where the FWPCA has determined that the channel and harbor contain polluted materials and where local authorities are unable to provide a suitable

alternate disposal area in 1968 have been individually considered. Where postponement of dredging would result in an economic hardship for the port and region, it is being accomplished as authorized by the Congress in the 1968 maintenance program, with the dredged materials placed in the authorized disposal area in the lake.

3. At three Lake Erie ports and in areas where the FWPCA has determined that there are no significant pollutants in the material to be dredged, the clean dredged materials will be placed in the authorized disposal areas in the lakes. Incidentally, that amounts to several thousand cubic yards. The figures that Congressman Ashley used this morning are somewhat frightening. I might just parenthetically remark here, too, that those measurements are made on an in-place basis at the bottom of the lake. The yard contains about fifty per cent water, so what he is talking about in the moving of fifty per cent of each cubic yard is moving water.

4. A report on the Pilot Program for determining alternate systems for disposal of polluted dredged materials will be completed by the end of 1968. The feasibility and efficacy of each method of handling, moving, treating and containing various types of polluted dredged materials and the applicability to each local port will be known.

5. The Pilot Program report may recommend use of alternate disposal areas for the disposal of polluted dredged material at some harbors where the material is now being placed in lake disposal areas. The report will consider and make recommendations for legislation, where appropriate, to include consideration of the share that local interests should bear of the costs of alternate disposal methods in accordance with the current policy for new projects. The report will also address itself to the question of economics of alternate maintenance methods.

All of us should recognize that after our report is submitted it will take some time to carry out its recommendations. If structures are to be built they must be designed and funded, then actually constructed. Funds must be appropriated for added costs of alternate disposal methods. These actions will undoubtedly take many months. Thus, we will continue to be faced with the necessity of disposing of some dredged materials in the open lake for some time to come.

Conclusion:

In summary, the Corps of Engineers agrees that everything possible should be done to find ways to ensure water of acceptable quality in the Great Lakes. The Corps is working with FWPCA and others to determine means of disposal and management of dredged materials so that they will not degrade the water quality of the lakes. We expect to complete the study in December of this year. We will stop placing dredge spoil in the lake from any harbor just as quickly as lands and dikes are provided; when it can be shown that a worse problem is not created; and when money to pay additional handling and treatment costs is provided. On the other hand, I will not recommend that the taxpayers' money be spent for costlier methods of disposal where it is doubtful that any benefit in pollution abatement or otherwise can be derived. It is essential that everyone understands that this problem of dredgings disposal implies local and State responsibilities also. Local interests may have to locate and provide suitable disposal areas if it is judged that pollutants in the dredged material will degrade the lake water, and may have to share with the Federal Government the added costs incurred. We need your understanding of the problem and your assistance in reaching a solution in the best public interest.

Immediate absolute interdiction of disposal of any dredged materials in the Great Lakes is as impracticable as telling the cities discharging heavy pollutants into the waters to discontinue the practice today. We can introduce whatever new harbor maintenance procedures that may prove to be necessary in the same time frame that communities are being given for adoption of improved treatment plants, and our problems will be greatly reduced as communities and industries effect a better treatment of their wastes. A transition period is needed. We are in that period, and I can assure you that whatever pollution problems there are associated with the maintenance of ports can be corrected in accordance with the same time schedule developed for other aspects of the clean waters program.

Thank you very much.

CHAIRMAN STEIN: Thank you, Colonel.

Are there any comments or questions?

MR. LYON: Yes, Colonel, you said, "I will not recommend that the taxpayers' money be spent for costlier methods of disposal where it is doubtful that any benefit in pollution abatement or otherwise can be derived."

Could you explain how you would decide that there would be a pollution abatement benefit from change in practice?

COL. WRIGHT: We haven't been able to find as yet that there would be a benefit from changing the practice, frankly. Now, there may be one. We have got people studying it, and we have got people trying to find out what the effect on fish life and bottom life is and whether the water quality is actually changed to any great degree by the dike disposal methods. We haven't found any yet.

MR. LYON: I assume we are both talking about polluted spoil material.

COL. WRIGHT: This is spoil material which contains pollutants.

MR. LYON: Yes. Well, the reason I make this point is because I am sure you are aware -- you heard this morning the amounts of money that are being spent by the city of Detroit and the city of Cleveland and the industries -- they are also not aware of the direct pollution abatement benefit, but this is based on a general assumption that by stopping to put pollution into the lake we are doing something good for the lake.

I did talk about the model idea. That might give us some of those answers; but the fact is that all of what these conferees here have recommended is based on a general assumption of a general benefit, and you are really proposing here a much more constrained evaluation of the benefit that really at this point we all agree cannot be done. We all have to agree that putting pollution into the lake is going to cause an adverse effect. That is generally the assumption we are operating on.

So, my basic question is: whether you would buy the assumption that all of the other polluters have bought, and that is that you have just got to stop putting pollution in the lake.

COL. WRIGHT: We are not opposed to altering our methods at all; and, as I say, we will start placing the spoil any place tomorrow when we get a place to put it and when we are convinced it doesn't cause a worse problem and when somebody gives us the money.

Now, as to a judgment as to whether this is going to be in the taxpayers' general interest or not, I am not going to recommend that something be done which I am not convinced will be of benefit to the taxpayer.

Now, if the intangible benefits are such that we can't place a dollar price on them and the intangible benefits indicate that it would be a good idea to spend this money, then we will make that recommendation.

MR. LYON: But, Colonel, you are trying to apply a cost benefit type philosophy to pollution abatement that the Corps has done effectively in flood control. We can't do that in water pollution control, and because we can't do it, our respective legislatures and the Congress have decided that it is in the general interest to abate pollution, and they have passed laws and made it a matter of public policy.

Now, the question is whether the Corps is willing to follow that type of broad evaluation of the benefit of not putting pollution into the lake.

COL. WRIGHT: We are certainly willing to put it any place that people give us money to put it, and our report will try to measure the benefits which the Bureau of the Budget has asked us to measure.

We placed a program of a $100 million before them and they turned it down. Apparently, they weren't convinced that it was worth spending that kind of money. They asked us to make a study. We are making that study and we will tell them the best we can whether it is to their benefit to appropriate the money to do it.

Now, I am not saying we won't recommend for or against at this point. I am saying that it is up to them to decide. I am saying it is very difficult to measure the benefits and that I am not going to recommend something that I am ultimately convinced will be a waste of the taxpayers' money.

CHAIRMAN STEIN: Are there any further questions?

You know something bothers me about this whole proposal and the study and maybe it needs a little clarification.

As I understand the Corps' action now, their policy now is when dredged materials are considered to be polluted by FWPCA, you find an alternate disposal site if it is available and put it there. Right? And you are spending extra money to do it.

COL. WRIGHT: No, we are not. If we can do it at the same cost, we do.

CHAIRMAN STEIN: In other words, you don't spend any extra money.

COL. WRIGHT: We don't have any extra to spend.

MR. LYON: See, this is where the problem is, Mr. Chairman, that the Corps is using a completely different philosophy in making pollution-abatement policy than we are.

CHAIRMAN STEIN: I understand. But why would you take a polluted material and, for example, not dump it on the land? I don't know about the Lake Erie situation, but I assume you have some land disposal areas around Lake Erie now of polluted materials.

Right?

COL. WRIGHT: Right.

CHAIRMAN STEIN: And you know the specifics in Lake Erie. Before you began putting them on land, you used to dump them in the lake, is that correct? You just changed?

COL. WRIGHT: To some extent, yes.

CHAIRMAN STEIN: Why are you doing that?

COL. WRIGHT: All right. Some of this is in the Pilot Program for which the Congress has provided money.

CHAIRMAN STEIN: Yes.

COL. WRIGHT: And some of it -- like at Maumee and Grassey Island -- it is more economical to place it on those areas.

CHAIRMAN STEIN: You haven't got an area/where you used to put polluted material in the lake, You are now putting it on the land? For example -- because I have been through this, I am a little more familiar with it -- in the past, the Corps was taking material out of Indiana Harbor and dumping it in the lake. Now, they have other means of disposing of that on land. I understand that they are doing it, because under the terms of the agreement that the Corps and FWPCA has entered into, if this material that has been dredged up from Indiana Harbor is considered to be polluted, they are putting it on the land or in the diked area. They used to put it in the lake. I believe, if I am not mistaken, that it is costing them a little more to do that.

COL. WRIGHT: That is why we are using the Pilot Program money in doing it.

CHAIRMAN STEIN: Now, what harm was it doing when you dumped that polluted material in the lake?

COL. WRIGHT: We haven't been able to detect any harm.

CHAIRMAN STEIN: Then why are you spending the taxpayers' money to put it on the land?

COL. WRIGHT: We have been told to make a study.

CHAIRMAN STEIN: Well, but you are doing more than the study. The Indiana Harbor is more than a study. I think that we have to come to grips with this operation, and I guess we have a copy of the agreement here, because this is the kind of thing that we may get hooked on. If we are committed right now to taking what is not polluted material and putting that in an alternate site right now and not putting it in the lake; if you contend that it isn't worthwhile doing unless you can demonstrate a harm then you have to assume that the polluted material, on which we have signed the agreement with the Corps of Engineers, is doing the harm. If it is not doing any harm, why do we get all of these high public officials together and get an agrement, sign it, and decide to go through this program, unless we adopt the notion that we are adopting the philosophy we have asked Detroit and Cleveland and all the other places to do: to keep the pollutants out of the lake.

Because it seems to me we have gone beyond the point of no return if this isn't doing anyone a bit of harm to put that stuff from Indiana Harbor -- and I know these Indiana boys are here -- I don't want to pick on them, but I am just familiar with that -- or from Calumet Harbor -- into the lake, and it is not doing the least bit of good. Why did we waste all of the taxpayers' money in going through this minutiae and making alternate arrangements to take the spoil from those places and putting it in alternate sites?

COL. WRIGHT: I think there is a general unconcern on the part of all of us -- myself included -- that we may indeed be doing some harm and it is worth looking into to find out, and that is why we are doing the study, and that is why we have concluded these agreements.

MR. LYON: You are a lawyer and I am not, but to me the Federal Water Pollution Act -- and I understand it doesn't just cover the States but also the Federal Government -- says, in effect, that pollution shall be abated. I don't think it says that pollution shall be abated if there is a direct measurable benefit. Am I correct about that? I don't think you heard me.

CHAIRMAN STEIN: I was looking for the agreement.

COL. WRIGHT: Were you addressing the question to me?

MR. LYON: No, I was asking --

CHAIRMAN STEIN: Go ahead.

MR. LYON: The question is: Does the Federal Act say that pollution shall be abated, period? Or does it say pollution shall only be abated if there is a measurable benefit?

CHAIRMAN STEIN: The Congress has not adopted a cost benefit theory on pollution abatement. Neither have any State legislatures. This has been proposed time and time again.

As you know, you have a definition of pollution in your legislature; all States have it. We have worked on a Suggested State Water Pollution Control Act with many people at this table that recommended it.

Under the Federal Act, any pollution which endangers health or welfare of any person is subject to abatement and this is not subjected to this cost-benefit theory.

Now, I would hate to think that we had a pollution measure by which we had to protect health and at the same time we would try to evaluate a cost-benefit theory and get some child sick or cause irreparable damage by putting that in. I would hope I wouldn't be given the task of figuring what the cost of that child's illness would be or putting that in a cost-benefit ratio. Maybe someone else could handle that, but I would excuse myself.

MR. LYON: Of course, we don't do that. Did the Congress in passing the Federal Water Pollution Act in any way exclude the Corps from this Federal policy?

CHAIRMAN STEIN: Well, now, you may have asked, as we say in the law, one question too many. The problem that we have in the Federal Act -- and this has been the problem with any Federal agency -- and this is the statutory construction in your State unless Congress says so specifically the sovereign doesn't regulate itself.

In other words, as we have pointed out many, many times, we are a sister agency with the Corps. We have no authority to tell the Corps what to do. We go before the same authorities as the Corps. Now, the Executive Order governs this or agreements govern this. We may be able to deal with a State or an industry or a municipality, but as far as another Federal agency our law does not cover that. The Executive Order does.

COL. WRIGHT: Mr. Lyon, I think this question of policy is really a fruitless debate here. We have been asked to respond to a Bureau of the Budget request that we put some kind of a dollar sign on benefits so that they can, in their wisdom, decide whether it is worthwhile or not to go into this amount of work.

Now, we are going to do our best to provide them with that kind of a dollar sign; and in doing so --

I think my statement is perfectly in order -- that we don't want to provide them with information on which we think it is useless to spend money. That is quite aside from the policy matter of the Federal Water Pollution Control Act in which the Congress has expressed what we believe to be the will of the people. It certainly is my will that we do everything possible to abate pollution. But when it comes around to the next day or the next month or the next year to provide the dollars to abate the pollution, they must have some kind of a yardstick to decide where to put the dollars. If we can give them some light which will help them make that decision so that they make the wisest decision, this is what we are obligated to do. I have no intention of representing the Corps of Engineers as being against any law that the Congress has passed or any feeling on the part of anybody that we can abate pollution.

I merely want to point out that we do have a problem that is not solvable overnight, and that it does have dollar and cents aspects to it which people are going to have to face up to.

CHAIRMAN STEIN: I can agree with all that. But let me make one point clear -- and I was trying to get this document here -- maybe you have it, Colonel, or someone in the Corps -- evidently we don't -- over and above the Bureau of the Budget request for a study, and the $1 million and the $5 million appropriations, there has been an agreement entered into between the Corps of Engineers and/or the Department of the Army and the Department of the Interior on a policy.

As I understand this agreement, it divides -- again, I am hesitant and I'd like the record to show this because I don't like to speak to anything of a real technical nature like that without having it before me -- but, in general, it classifies the dredged material in several classes.

On the one hand, you get the materials which are classified as polluted, and, on the other extreme are relatively benign materials if they were discharged in the water.

As I say, I have read this agreement very, very carefully. The only reason I am hesitant is because I don't have it before me. But as I recall the agreement, if there are polluted materials such as we have found in many harbors, we are, right now, to find alternate methods of disposal of those materials.

Is that correct?

COL. WRIGHT: If they can be found, that is right.

CHAIRMAN STEIN: That is right.

Now, the question -- and this gets me to Mr. Lyon's motion -- in other words, it seems to me the underlying assumption, then, is that if we find the polluted material, we are going to try to keep that out of the lake as we ask every city and every industry and every other Federal installation and the shore Federal installations to do. We do that regardless of whether we can find a cost-benefit ratio when that polluted material hits the lake.

COL. WRIGHT: That is right.

CHAIRMAN STEIN: I share your doubts on that. I am not sure that if we follow a barge out -- and I have done this and I have examined the material -- and we see that the barge dumps in the lake that we can really assess any tangible damage. I am not sure that this can be done.

As I understand the agreement, the views of the State governments and the Federal Government are that we don't apply that kind of test in pollution control because what we do know -- particularly in something like a lake or a river -- is that if we take a lot of little sources and put them together, we get one big mess and this is the problem. So we apply what Mr. Lyon said -- this is implied right in the agreement that our Secretary and the Secretary of the Army have signed-which is that if there are polluted dredgings, we will do everything we can to keep them out of the lake without really regard for a cost-benefit. We are not doing that study to justify or not justify or let somebody make a public policy judgment on the Federal funds, but on the present operation. We are operating under that understanding.

COL. WRIGHT: I don't know that I can agree completely with you, sir, but I don't think we need to take up the time.

There are two agreements that have been executed: one is with respect to permit dredging, and in that instance, we do submit every application to the Department of Interior; and, as I say, not a single one has been granted. With respect to the other agreement, it is an agreement that we will undertake a study, In connection with that study, we have agreed on a rather informal basis that each harbor, during the period of this study and in the subsequent months thereafter until we can implement it, we will, with the Department of Interior, consider each harbor individually and sit down and decide what is the best policy for that harbor. We have done that for this year's dredging. Presumably we will do it again for next year's dredging.

When we sat down in December with the Department of Interior, we told them: we will put every bit of dredging we can behind dikes, and we went over each harbor and the Department of Interior agreed with us as to which ones we could stop putting any dredging, which ones we could find places to put something and which ones we could go ahead and continue dumping in the lake.

We will presumably do that again before the 1969 season. I think that accurately represents what has happened.

CHAIRMAN STEIN: Again, let me make one point. We sometimes have an assumption -- I think the Colonel alluded to this in his statement -- where we give a city or an industry a reasonable amount of time to put in abatement procedures.

I think when we are dealing with dredged materials or the Corps of Engineers -- let's adopt the assumption that we want a good measure of this dredging, in any event, to be stopped -- we have to, it seems to me, give the Corps and its operations the same kind of consideration that we are going to give to any city or any industry around this lake.

In other words, if we are going to give them a reasonable time, we must consider that we are going to give the Corps of Engineers the same reasonable time. When we are asking them to do something, we are going to have to ask them to do something that is feasible, reasonable and technically obtainable, the same way we ask the city or an industry. On the other side, these are the considerations that sometimes we begin to lose sight of. The fact we are dealing with the Government agencies doesn't mean that suddenly you can wave a magic wand and stop this overnight. If that is the view, then we should stop everyone overnight and we just don't do that.

From our point of view -- at least I am speaking from the Department of the Interior point of view -- on the question of a time schedule operation, we are thinking of them in the same kind of framework that we think of other people.

Are there any other comments or questions?

MR. METZLER: I would like a comment.

CHAIRMAN STEIN: Yes.

MR. METZLER: Well, it seems to me if we are not careful that we make the Corps of Engineers or some other public agency a whipping boy in this matter. I don't see how we can solve this problem of dredged material and siltation in the lakes without going back and solving it just like you solve any other pollution abatement problem and that is cutting it off at the source.

Now, this conference recognized that, at least to some extent, by one of the previous meetings, in asking the United States Department of Agriculture to come in with some recommendations for reducing soil erosion and the washing in of high nutrient materials including barnyard manure.

I think this matter has to be pressed hard and I think we, as professionals, are doing a very bad service to the public when we indicate that we can stop the eutrophication of Lake Erie and clean up Lake Erie without attacking this problem. This is what I will recommend to the conferees: that we again remember that earlier request of the United States Department of Agriculture and the Soil Conservation Service; and that further, then, we go back to our own State agencies, particularly the State Soil Conservation Service or State Boards or Departments of Agriculture, and whatever, the State Agency or Department of Public Works, Transportation or Highways, because this is where most of this silt is coming from. It is from construction or it is agriculturally related, and until we can cut down the source substantially we are just going to have this problem of transferring the sediments around and maybe we will pile them out on the land awhile or maybe we will put them out in the water where it is deep.

I think this is one of the items to which this conference should give some serious attention.

CHAIRMAN STEIN: I would agree. I would like to suggest one addendum to what you say: In many of the harbors, the Corps is dredging up wastes. A lot of these wastes don't come necessarily from the farms, but they are industrial wastes. The Corps didn't put those in the harbor. If we had -- and this goes for the States and the municipalities and the industries -- if we had really effective waste treatment facilities, we wouldn't have that amount of wastes that are going in.

Now, here we have industrial harbor after industrial harbor on the lake. Maintaining the economic viability of the harbor you have to have that channel of a certain depth to get a boat of a certain size in there or else it is not going to be economical, and then that channel and harbor gets filled up, and where is that waste coming from? From the same industry that is getting the benefit of that deep harbor.

And the point is: If you expect the Corps, again, to be not only a dredger but a scavenger for this kind of stuff, you have to assess the responsibility.

There is one other point that I really would like to make because when we get off on this we begin losing perspective. Whether we deal with these peripheral problems like oil-well drilling, boat pollution, disposal of soil, as far as pollution of Lake Erie and generally of pollution almost anywhere these are really, really minor items and don't forget it. They are intriguing items but they are minor items.

The big major source of pollution comes from the fixed-shore installations, the big cities and big industries.

If the Corps went to work and worked all year dredging those harbors and got that maximum appropriation -- and took all their wastes and just dumped it willy-nilly -- if they did that, which they don't -- into the lake, they couldn't begin to compete with one of the real big cities and big industries pouring out their wastes 24 hours a day every day in the year. And this is the thing that we have to remember: that when we are dealing with these dredgings, we are dealing with a refinement here, and the essential part of the pollution problem really does not rest with any aspect, I don't think, of the Corps' operations.

Are there any other comments or questions?

If not, thank you very much, Colonel.

MR. POSTON: That is the end of the Federal presentation.

CHAIRMAN STEIN: Let's call on Indiana, Mr. Poole.

MR. POOLE: Mr. Chairman, Perry Miller, who is Director of the Bureau of Engineering, is with us, and he will abstract the Indiana report. It is in seven pages. There is a considerable amount of repetition from the 1967 report, and in the interest of time I hope Perry will leave most of that out.

CHAIRMAN STEIN: All right, but the whole report without objection will appear in the record as if read.

(The above-mentioned report follows.)

MR. MILLER: All Indiana municipalities with recognized sewer systems have secondary type sewage treatment facilities. Increased surveillance of plant operation by representatives of the Stream Pollution Control Board has resulted in better operation, increased laboratory analyses and more meaningful operation reports. Implementation of the mandatory certification program (effective July 1, 1968) will provide additional control over operation of all wastewater treatment plants.

The Maumee River Plant, operated by the private corporation of Diversified Utilities, is designed for a flow of 0.5 mgd. The activated sludge-type plant with effluent chlorination is now serving approximately 3,000 equivalent residential customers. The plant is operating above hydraulic capacity. Although plans for expansion have been approved, construction has not been undertaken. Diversified Utilities has filed a petition for reorganization under the Bankruptcy Act and a trustee has been appointed. The treatment facilities are being operated; however, construction of improvements is not indicated in the near future. Some consideration is being given by the city of Fort Wayne to the feasibility of taking over operation of the facilities.

The city of Fort Wayne sewer crew provides routine inspection of flow-regulating structures on combined sewers and inspection following runoff from rainfall to minimize overflow to receiving waters. Inspections of all overflow structures are made at least weekly; some inspections are daily or every other day in connection with servicing of lift stations. In other municipalities flow-regulating structures are maintained to minimize overflows. Representatives of this office inspect bypass structures during routine surveillance visits. Combined sewer systems are not being proposed or approved in newly developed urban areas.

Construction is underway on the facilities to abate the discharge of lime sludge from the water treatment plant to the Maumee River. This project should be completed in 1968.

The superintendents of municipal sewage treatment plants advise this office of unusual conditions that cause a material increase in the waste load discharged to the receiving stream.

Effluent Chlorination

The cities of Auburn and Garrett are chlorinating plant effluents routinely. The city of Decatur is now going over its chlorination facilities prior to placing effluent chlorination in operation. The town of Waterloo is completing construction of new effluent chlorination facilities.

The municipalities of Avilla, Butler, and Berne expect to submit plans for effluent chlorination facilities to the Stream Pollution Control Board prior to July 31, 1968. The change of municipal officials as of January 1, 1968, delayed completion of plans for these municipalities. In addition, the city of Fort Wayne is completing plans for effluent lagoons that will also receive flows in excess of plant capacity. This project will include provisions for chlorination of plant effluent. Plans have been approved for plant additions, including effluent chlorination, at New Haven. All of these municipalities plan to file applications for P.L. 660 funds for fiscal year 1969.

I might say here, in connection with the statements that you heard this morning from Mr. Remus and Mayor Stokes that the financing in the municipalities is connected with the grants program.

Phosphate Removal

The city of Fort Wayne has a grant of $283,200 to help finance pilot plant studies on phosphate removal. The original meeting relative to a phosphate removal project was held with representatives of the Department of Health, Education, and Welfare on August 26, 1965. Initial efforts were directed towards negotiating a contract for phosphate removal studies between the City and the Federal Water Pollution Control Administration; however, this approach was not finalized. A formal application was filed on May 1, 1967, and the revised application which was approved on March 19, 1968, was filed on July 7, 1967. As studies proceed on this project, Fort Wayne and adjoining municipalities will have better guidelines on which to base the design of plant scale projects.

As all municipalities with recognized sewer systems had secondary treatment facilities in operation (except the town of Avilla, which was under construction) prior to the Lake Erie Conference, existing plants were not designed to maximize the removal of phosphorous. However, as information is made available relative to phosphorous removal at existing facilities, the municipalities will be required to instigate action to improve removals. Plans submitted for new or improved facilities will be required to provide facilities for phosphorous removal.

Industrial

Of the 22 industries in the basin, 16 have adequate waste control facilities and six need additional treatment works. Of the six that have inadequate treatment, four have waste treatment projects in the planning stage and one pollution control project is under construction. A hearing was held on April 17, 1968, concerning the pollution of Cedar Creek by Kitchen-Quip, Inc., Waterloo. An order to abate pollution will be acted on at the June 18, 1968, Board meeting.

Effluent monitoring programs have been established and maintained at sixteen of the twenty-two industries. The remainder of the industries were not required to establish effluent monitoring programs because no effluent is discharged to the receiving stream. The monitoring program has been discontinued at Parrot Packing Company because connection is being made to the Fort Wayne sewerage system. The monitoring data are maintained in open files.

Maumee River Basin

Salisbury Division, Dana Corporation, Fort Wayne

The waste treatment facilities, reported as adequate at the August 1965 Conference, continue to provide a satisfactory effluent. An adequate effluent monitoring program is being maintained.

Essex Wire Corporation, Fort Wayne

The corporation has since February 1967, discharged all wastewater to the Fort Wayne sewerage system.

The corporation continues to provide adequate waste control.

Franke Plating Works, Inc., Fort Wayne

Preliminary plans for cyanide destruction, chromium reduction and precipitation and acid-alkali neutralization facilities were considered satisfactory by the Board on September 19, 1967. Final plans and specifications are nearing completion by the consulting engineer. A partial effluent monitoring program is being maintained and will be expanded when treatment facilities are completed. The industry plans to meet the December 31, 1968, completion date, established by the Board.

General Plating and Engineering, Inc., Fort Wayne

On October 26, 1967, the Board and the Company entered into a stipulation whereby the Company is to prepare plans and specifications for waste treatment facilities and to complete construction of approved facilities by December 1, 1968. Preliminary plans for cyanide destruction, chromium reduction and precipitation and acid-alkali neutralization facilities were considered satisfactory by the Board on December 19, 1967. Final plans and specifications are nearing completion by the consulting engineer. A partial effluent monitoring program is being maintained and will be expanded when treatment facilities are completed. The industry plans to meet the December 1, 1968, completion date established by the

Board.

Gladieux Refinery, Inc., Fort Wayne

The waste treatment facilities reported as adequate at the August 1965 Conference continue to provide a satisfactory effluent. An adequate effluent monitoring program is being maintained.

I.T.T. Industrial Laboratories, Fort Wayne

The waste treatment and control facilities reported as adequate at the August 1965 Conference continue to provide a satisfactory effluent. An adequate effluent monitoring program is being maintained.

International Harvester Company, Fort Wayne

All contaminated wastewater from the plant has been connected to the Fort Wayne sewerage system with the exception of the southeast area of the plant. This wastewater will be intercepted by a sewer which is under contract for construction by a sewer utility for discharge to the Fort Wayne sewerage system. An adequate effluent monitoring program is being maintained.

The Magnavox Company, Fort Wayne

The waste treatment and control facilities reported as adequate at the June 22, 1966, meeting of the conferees continue to provide a satisfactory effluent. An adequate effluent monitoring program is being maintained.

Parrot Packing Company, Fort Wayne

An order to abate pollution of the Maumee River was issued by the Board on May 3, 1967. The compliance date for completion of waste control facilities was set for December 31, 1968. During 1967 the Company entered into an agreement with a sewer utility and the city of Fort Wayne to discharge wastewater to the Fort Wayne sewerage system. Construction of the sewer is nearing completion, but is being delayed because of court action initiated by a property owner concerning sewer connection fees. The project can be completed within 30 to 45 days after the court case is settled.

Phelps Dodge Copper Products Corporation, Indiana Rod and Wire Division, Fort Wayne

The waste treatment facilities reported as adequate at the June 22, 1966, meeting of the conferees continue to provide a satisfactory effluent. An adequate effluent monitoring program is being maintained.

Zollner Corporation, Fort Wayne

All contaminated wastewater continues to be discharged to the Fort Wayne sewerage system as reported at the June 22, 1966, meeting of the conferees.

B. F. Goodrich Company, Fort Wayne

The waste treatment facilities reported as adequate at the August 1965 onference continue to provide a satisfactory effluent. An adequate effluent monitoring program is being maintained.

Shaw's Dressed Poultry, Grabill

The waste treatment facilities reported as adequate at the August 1965 Conference continue to provide adequate waste treatment.

St. Joseph River Basin

Crane Edmund Corporation, Butler

The waste treatment facilities reported as adequate at the August 1965 Conference continue to provide a satisfactory effluent. An adequate effluent monitoring program is being maintained.

Universal Tool and Stamping Company, Inc., Butler

The conversion to a non-cyanide plating solution was not successful and the use of static rinse tanks has not reduced drag-out of cyanide and zinc to acceptable levels. The Company is working on plans for treatment facilities. The Board expects the Company to meet the December 31, 1968, completion deadline and will institute necessary legal proceedings to insure compliance.

Kitchen-Quip, Inc., Waterloo

On April 17, 1968, the Board held a hearing concerning the pollution of Cedar Creek below the plant. The hearing officer has recommended that a pollution abatement order be issued. The proposed order will be considered by the Board at the meeting scheduled for June 18, 1968. The proposed order requires completion of facilities by December 31, 1968.

T. H. Products Corporation, Waterloo

The waste treatment facilities listed as adequate at the August 1965 Conference continue to provide adequate control. No effluent is discharged to the receiving stream.

Auburn Tankage Company, Auburn

The waste treatment facilities listed as adequate at the August 1965 Conference continue to provide adequate control. No effluent is discharged to the receiving stream.

County Line Cheese Company, Auburn

The Company has submitted preliminary plans for additional spray irrigation facilities to augment the present holding lagoon and broad irrigation facilities. Recent inspections show that no effluent is discharged to the receiving stream.

Warner-Motive Division, Borg-Warner Corporation, Auburn

During the fall of 1967, three oil separation basins and a waste stabilization pond were completed for treatment of 80,000 gpd of oily wastewater from the plant. Adequate waste treatment is now being provided. The effluent monitoring program is being revised to reflect the operation of the new facilities.

Ralph Sechler and Sons, Inc., St. Joe

The waste treatment facilities reported as adequate at the March 22, 1967 meeting of the conferees continue to provide a satisfactory effluent. A five hp mechanical aerator was recently installed in the waste holding pond to eliminate odors and improve BOD reductions. An adequate effluent monitoring program is being maintained.

St. Mary's River Basin

Central Soya Company, Inc., Decatur

The waste treatment facilities reported as adequate at the August 1965 Conference continue to provide a satisfactory effluent. An adequate effluent monitoring program is being maintained.

In summary:

1. The Stream Pollution Control Board has continued efforts to comply with recommendations of the conferees.

2. All municipalities with recognized sewer systems have secondary treatment works in operation. Surveillance of plant operations by representatives of the Board has increased, resulting in improved operation. All municipalities are either disinfecting plant effluents

or are preparing plans to do so.

3. The city of Fort Wayne received a grant on March 19, 1968, to help finance pilot plant studies on phosphate removal which will aid in the development of guidelines for the design of plant scale projects.

4. All industries which are required to provide effluent monitoring are maintaining such monitoring programs.

5. The Board initiated legal action against Parrot Packing Company, General Plating and Engineering, Inc., and Kitchen-Quip, Inc. An order was issued to Parrot Packing Company, General Plating and Engineering stipulated to construct the needed treatment works, and the Board will consider issuing an order to Kitchen-Quip at its meeting scheduled for June 18, 1968. The Board will initiate action to secure construction of needed facilities whenever it becomes necessary.

6. Sixteen of the twenty-two industrial plants provide adequate waste control facilities; one is constructing facilities; and the remaining five are expected to complete facilities by December 1968.

7. The Board has continued its stream monitoring program of waters within the Maumee Basin.

Thank you.

CHAIRMAN STEIN: Thank you.

Any comments or questions?

As usual, this is an excellent report, except for the phosphate situation. As I understand it, your municipalities and industries are on schedule and those few that aren't the Board will follow through with orders.

MR. MILLER: We are on schedule with the exception of those on chlorination which I indicated would be May of 1969.

CHAIRMAN STEIN: Is that because of the delays in ordering equipment?

MR. MILLER: No, this is a question of change of administrations, and a change sometimes in engineering firms as well, and new administration preparing plans, and then also tied in with the financing.

CHAIRMAN STEIN: Let me make this general statement: Aside from the question of phosphates, which we will get into, I would say that Indiana represents compliance with the schedule. There are a few slippages, but these slippages I think even viewed themselves are minor, but viewing the overall program they are relatively minor and they are inevitable I think in getting any program underway.

Is there any other judgment on that?

MR. OEMING: Very good judgment.

MR. METZLER: Just one comment: Since it would hardly be fitting for the member from Indiana to raise the question that he has raised with all of the other States, does the accomplishment of this additional work rest pretty heavily upon some Federal participation in the construction grants?

MR. MILLER: I attempted to answer this, Mr. Metzler, in the presentation -- that it does depend upon the Federal grants because all of these cities are expected to make application for Federal grants. Here I might say that Indiana does have a grant program as well, and this is tied in with the Federal, so they are expecting both State and Federal money to complete these projects.

MR. METZLER: It wasn't that I didn't hear your statement the first time you made it, I just wanted to give you the advantage of having it highlighted the same as the other State representatives had.

MR. POOLE: Thank you, Mr. Metzler.

CHAIRMAN STEIN: Does that complete Indiana?

MR. POOLE: Yes.

CHAIRMAN STEIN: How about Michigan?

MR. OEMING: Mr. Chairman, conferees. I would like to introduce Mr. Ralph Purdy, Chief Engineer. With your permission, I would like to ask him to give the report on behalf of the Water Resources Commission, and I also have Mr. Nicholas V. Olds, and he is the Legal Counsel for the Commission, Assistant Attorney General, in case there are any legal questions you might want to ask him.

MR. PURDY: Some place in the stack of material before you, you will find a gray covered report and two green reports, marked Appendix D and Appendix E.

Mr. Chairman, we would like to have the gray report placed in its entirety in the record. The green reports, Appendix D and Appendix E, are mentioned in the gray report. They are furnished to the conferees for their information. It is not necessary to have them in the conference record.

CHAIRMAN STEIN: Without objection, this will be included as if read.

(The above-mentioned report follows. Also, Appendix D and E are on file at the FWPCA Regional Office, Chicago, Illinois, and the FWPCA Office, Washington, D.C.)

MR. PURDY: At the reconvened conferences in Cleveland in 1966 and in Buffalo, New York, in 1967, the Michigan Water Resources Commission reviewed the pollution control program that had been developed to abate pollution and enhance the Michigan waters of Lake Erie and its tributaries. The reports outlined how Michigan, in 1965, had established water quality goals for the Detroit River and Michigan waters of Lake Erie and how a voluntary pollution abatement program had been formed with the help of industries and municipalities. The reports

FOR RECONVENED CONFERENCE

FOURTH SESSION

ON

POLLUTION OF THE INTERSTATE AND OHIO INTRASTATE WATERS OF LAKE ERIE AND ITS TRIBUTARIES

(INDIANA-MICHIGAN-NEW YORK-OHIO-PENNSYLVANIA)

CALLED BY
MURRAY STEIN, CONFERENCE CHAIRMAN
DEPARTMENT OF THE INTERIOR

STARTING JUNE 4, 1968
CLEVELAND, OHIO

ON BEHALF OF
THE
MICHIGAN WATER RESOURCES COMMISSION

MAY 1968

MICHIGAN WATER RESOURCES COMMISSION

GEORGE F. LIDDLE, Chairman, Muskegon, Municipal Groups

R. G. RICE, M.D., Director of the Department of Public Health
John E. Vogt, Representing the Director, Vice Chairman

B. DALE BALL, Director of Agriculture

GERALD E. EDDY, for RALPH A. MAC MULLAN, Director of Conservation

JOHN P. WOODFORD, for State Highway Commission

LYNN F. BALDWIN, Eaton Rapids, Conservation Groups

JIM GILMORE, JR., Kalamazoo, Industrial Management Groups

LORING F. OEMING
EXECUTIVE SECRETARY

PURPOSE

At the reconvened conferences in Cleveland in 1966 and in Buffalo, New York in 1967, the Michigan Water Resources Commission reviewed the pollution control program that had been developed to abate pollution and enhance the Michigan waters of Lake Erie and its tributaries. The reports outlined how Michigan, in 1965, had established water quality goals for the Detroit River and Michigan waters of Lake Erie and how a voluntary pollution abatement program had been formed with the help of industries and municipalities. The reports further set down the effluent restrictions and treatment facility construction time schedules required to achieve the desired water quality goals. Finally, the reports described the water quality surveillance and effluent monitoring programs that have been established by the Michigan Water Resources Commission.

This report will review the compliance status of the previously approved abatement programs and time schedules and will present information on recent pollution control activities affecting water quality in Michigan's waters of Lake Erie.

INDUSTRIAL AND MUNICIPAL COMPLIANCE STATUS

Appendix A summarizes the performance status of the 25 industrial plants and 11 municipal governmental units having Stipulations with the Water Resources Commission to control the polluting content of their waste discharges to the Detroit River and Lake Erie. In 3 cases out of 11, municipal performance schedules have been modified to accommodate expanded waste control projects, and 4 industrial schedules have been modified to allow for unforeseen construction delays. The 4 paper mills in the Monroe area have decided to join the metropolitan waste treatment system and their compliance dates are now considered to be the same as for the City of Monroe. Even under the revised performance schedules, all municipalities and industries are scheduled to have treatment facilities in operation by December 1, 1970. Six industries have waste control facilities in operation and are meeting the stipulated effluent restrictions. One municipality and 3 industrial plants have not met the provisions of recent performance dates and each will be reviewed by the Water Resources Commission at an early date.

WATER QUALITY STANDARDS

Since the 1967 reconvened conference, Michigan has adopted water quality standards for all interstate waters, including Michigan's waters of Lake Erie, along with designated use areas and a plan of implementation. The standards, use areas and plan of implementation have been approved by the Secretary of the Interior with the single exception of a part of the temperature standards. This program data is detailed in Appendix B. Michigan is also proceeding with a program to develop comparable water quality standards for intrastate waters.

WATERCRAFT POLLUTION CONTROL

The Water Resources Commission was directed by Governor Romney to develop rules and regulations for the control of sanitary waste discharges from recreational watercraft. The rule was developed in cooperation with the Department of Health, the Waterways Commission and other affected state agencies; and in consultation with neighboring states and the Province of Ontario. The rule is designed for application to all watercraft equipped with a marine toilet, with the exception of passenger or cargo-carrying vessels subject to the Interstate Quarantine Regulations of the U. S. Public Health Service. The rule requires that after January 1, 1970 all watercraft having a marine toilet must be provided with either a holding tank, a sewage incinerator or a device which has been determined by the Commission to be capable of rendering the sewage discharges non-pollutional. (See Appendix C.)

WATER QUALITY SURVEILLANCE OF THE MICHIGAN WATERS OF LAKE ERIE AND ITS TRIBUTARIES

The water quality surveillance program established by Michigan was described in detail to the conferees at Buffalo in 1967. The sampling and testing of the Detroit River and Lake Erie at 63 locations is continuing and the data obtained during 1966 and 1967 have been tabulated in Appendix D. Similar data for the 75 municipal and industrial waste discharges along the Detroit, Rouge, Huron and Raisin rivers is shown in Appendix E.

APPENDIX A

INDUSTRIAL AND MUNICIPAL PERFORMANCE STATUS

DETROIT RIVER-LAKE ERIE GOVERNMENTAL UNIT STIPULATION DATES FOR COMPLIANCE

Unit	Preliminary Engineering Study and Basis of Design	Approval of Construction Plans and Specifications	Complete Construction	Comments
Berlin Township	May 1, 1967	May 1, 1968	May 1, 1969	Preliminary design and report completed. Township has notified the Commission that it has been unable to proceed with final plans due to financing problems. Commission will review problem at an early date.
Frenchtown Township	May 1, 1967	(May 1, 1968)* November 30, 1968	(May 1, 1969) December 1, 1970	Township has joined the Monroe metropolitan system with treatment of wastes at the City plant. New compliance dates were recently approved due to expanded service area and coordination with the metropolitan treatment plant improvement construction schedule.
Monroe Township	May 1, 1967	(May 1, 1968) November 1, 1968	(May 1, 1969) May 1, 1970	Township has joined the Monroe metropolitan system with treatment of wastes at the City plant. New compliance dates were recently approved due to expanded service area and coordination with the metropolitan treatment plant improvement construction schedule.
Grosse Ile Township	April 1, 1967	November 1, 1968	November 1, 1970	Preliminary plans approved. In compliance.
Wayne County	April 1, 1967	November 1, 1968	November 1, 1970	Preliminary plans approved. In compliance.
City of Detroit	April 1, 1967	November 1, 1968	November 1, 1970	City was also to submit a report on combined sewer overflow control by April 1, 1968. The report has been received and approved. City is in compliance.
Village of Estral Beach	May 1, 1967	May 1, 1968	May 1, 1969	Preliminary engineering study report was received and approved timely. Due to the estimated high per capita cost of the proposed municipal system, the Village elected to upgrade individual disposal systems. Notification has been received from the Village and the Monroe County Health Department that complete abatement has been achieved. Confirmation studies by Commission staff have been scheduled.
City of Luna Pier	May 1, 1967	May 1, 1968	May 1, 1969	Final plans approved. In compliance.
City of Monroe	May 1, 1967	(May 1, 1968) November 1, 1968	(May 1, 1969) December 1, 1970	Contractual agreements have been reached with the three Monroe area paper companies and two adjoining townships for joint waste treatment in the City's plant. Compliance dates were recently modified due to the expanded scope of the collection and treatment project.
City of Riverview	April 1, 1967	November 1, 1968	November 1, 1970	Preliminary plans approved. In compliance.
City of Trenton	April 1, 1968	November 1, 1969	November 1, 1970	Preliminary plans approved. In compliance.

*Original Stipulation dates shown in parentheses with current compliance dates shown directly below the original.

DETROIT RIVER-LAKE ERIE INDUSTRY STIPULATION DATES FOR COMPLIANCE

Industry	Preliminary Engineering Study and Basis of Design	Approval of Construction Plans and Specifications	Complete Construction	Comments
Allied Chemical Corporation				
Semet Solvay Division, Detroit		April 1, 1966	April 1, 1967	Facilities in operation. In compliance.
Solvay Process Division, Detroit		November 1, 1966	April 1, 1968	The Company will cease operations at this location as of January 1, 1969. Action on the Company's request for this extension is pending.
American Cement Corporation				
Peerless Cement Division, Detroit		May 1, 1966	May 1, 1967	Facilities in operation. Monitor sampling shows the Company to be near compliance. Additional studies are presently being undertaken by the Company.
Consolidated Packaging Corporation				
North Side Plant, Monroe	January 1, 1967	(January 1, 1968)* November 1, 1969	(January 1, 1969) December 1, 1970	The Company has entered into a contract for secondary treatment of wastes in the Monroe municipal metropolitan treatment plant. Compliance dates are now deemed to be the same as for the City of Monroe.
South Side Plant, Monroe	January 1, 1967	(January 1, 1968) November 1, 1969	(January 1, 1969) December 1, 1970	The Company has entered into a contract for secondary treatment of wastes in the Monroe municipal metropolitan treatment plant. Compliance dates are now deemed to be the same as for the City of Monroe.
Darling and Company, Melvindale		November 1, 1966	(December 1, 1967) September 1, 1969	Considerable waste reduction has been accomplished through in-plant changes. A program of equipment conversion is now underway which, when complete, will produce an effluent much better than required under the stipulation. Construction of an interim aerated lagoon is also underway which will provide near compliance by June 1968. A final compliance date modification was granted by the Commission in February 1968 to facilitate the plant conversion program.
E. I. duPont deNemours and Company, Inc.				
Industrial and Biochemical Division, Ecorse		April 1, 1966	April 1, 1967	Facilities in operation. Partial compliance established. Operations at this location will cease on July 31, 1968.
Firestone Tire and Rubber Company				
Firestone Steel Products Division, Riverview		November 1, 1966	November 1, 1967	The Company has entered into a contract for the hauling away and disposition of all the spent pickle liquor and no longer discharges this material to the Detroit River.
Ford Motor Company				
Monroe Plant		December 1, 1966	(+24 months) February 15, 1969	Construction plans were submitted timely and approved February 15, 1967 thereby establishing the firm, construction completion date shown.
Rouge Plant other than iron and suspended solids		October 1, 1967	(+17 months) [illegible]	Construction plans have been approved. Additional nine months construction time was granted due to changes in the scope of the construction project for chemical treatment. Oil control facilities are substantially complete except for construction of holding ponds that require coordination with U.S. Corps of Engineers, Rouge River improvement project. An extension of time has been requested to October 1, 1969.
Iron		March 1, 1967	(+24 months) April 15, [illegible]	Conversion to hydrochloric acid steel pickling lines with all spent pickle liquor returned to supplier is expected to eliminate all such discharges from [illegible] the end of 1967 [illegible]
suspended solids		March 1, 1967	(+27 months) June 1, 1969	Plans received and approved timely.

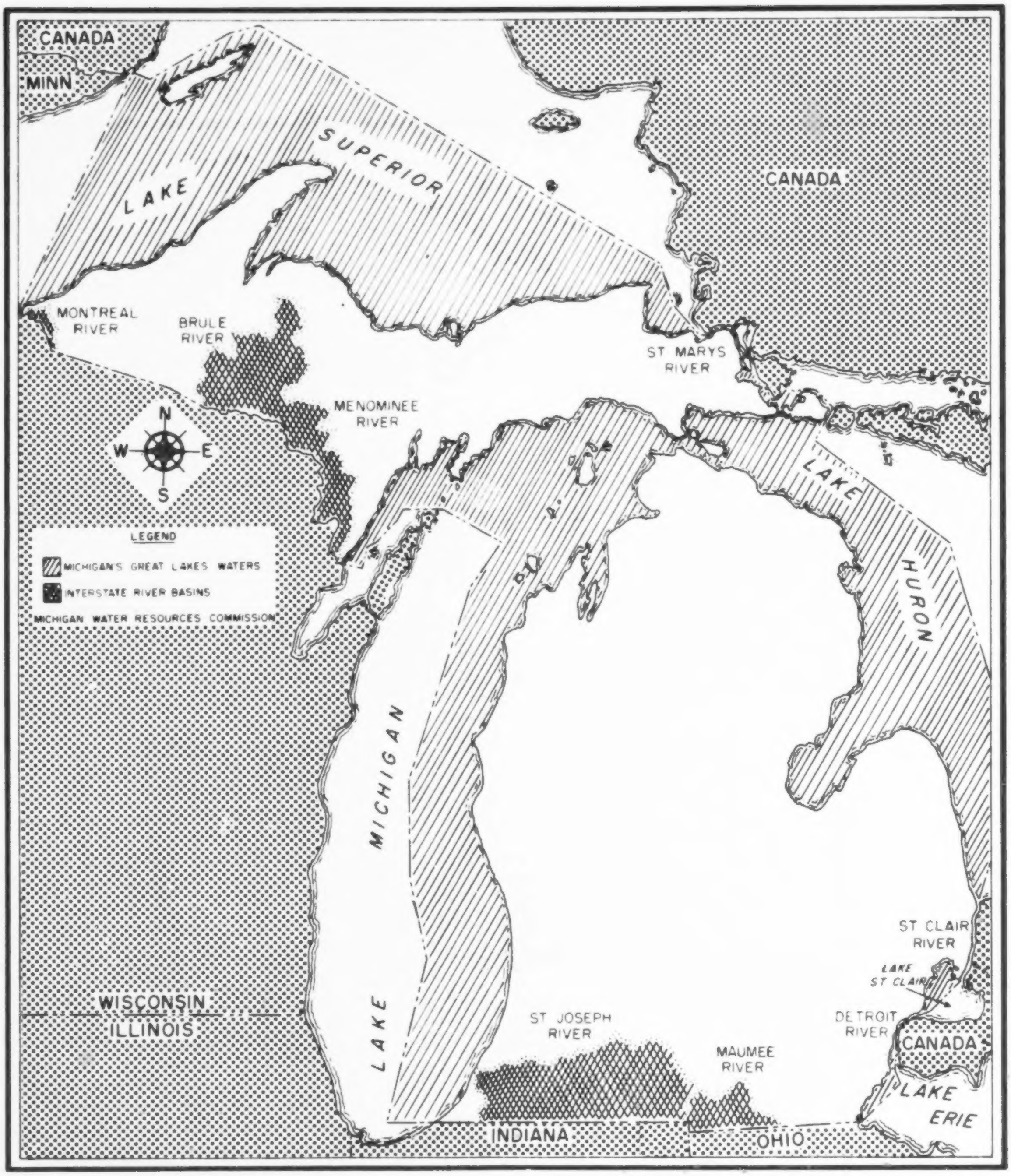
Great Lakes Steel Corporation				
80" Hot Strip Mill, Ecorse		November 1, 1966	April 1, 1968	Facilities in operation and in compliance.
Steel Rolling Mill, Ecorse other than acid and iron		November 1, 1966	April 1, 1968	Facilities in operation and in compliance.
other than acid and iron, No. 3 slabbing mill		October 1, 1967	October 1, 1968	Plans approved, facilities under construction.
acid and iron	April 1, 1967	December 1, 1967	April 1, 1969	Construction plans were submitted and approved timely.
Blast Furnace, River Rouge		November 1, 1966	April 1, 1968	Partial compliance obtained. Oil and suspended solids still exceed limits in some outlets. Additional improvements being made by Company which are expected to result in compliance.
McLouth Steel Corporation, Trenton		November 1, 1966	April 1, 1968	Facilities in operation and in compliance.
Mobil Oil Company, Trenton		November 1, 1966	November 1, 1967	Facilities in operation. Company is slightly in excess of oil concentration limits and has plans for additional treatment lagoons.
Monsanto Company				
Trenton Plant	November 1, 1967	August 1, 1968	November 1, 1969	Plans have been approved, construction has been completed and facilities are in operation.
Trenton Resins Plant	(November 1, 1966) September 1, 1967	(April 1, 1967) December 1, 1967	(April 1, 1968) September 1, 1968	Compliance dates were revised to allow for additional plant studies. Plans have been submitted and approved timely. Construction underway.
Pennsalt Chemicals Corporation				
East Plant, Wyandotte		November 1, 1966	April 1, 1968	In compliance.
West Plant, Riverview		November 1, 1966	April 1, 1968	Not in compliance. Commission will review the problem at an early date.
Revere Copper and Brass, Inc., Detroit		November 1, 1966	November 1, 1967	Facilities have been installed. Compliance not fully established. Commission will review the problem at an early date.
Scott Paper Company, Detroit for BOD	January 1, 1968	January 1, 1969	January 1, 1970	Preliminary plans received and approved timely.
for solids		May 1, 1967	(May 1, 1968) August 19, 1968	Facilities under construction.
Time Container Corporation				
Monroe Paper Products Division	January 1, 1967	(January 1, 1968) November 1, 1968	(January 1, 1969) December 1, 1970	The Company has entered into a contract for secondary treatment of wastes in the Monroe municipal metropolitan treatment plant. Compliance dates are now deemed to be the same as for the City of Monroe.
Union Camp Corporation, Monroe	January 1, 1967	(January 1, 1968) November 1, 1968	(January 1, 1969) December 1, 1970	The Company has entered into a contract for secondary treatment of wastes in the Monroe municipal metropolitan treatment plant. Compliance dates are now deemed to be the same as for the City of Monroe.
Wyandotte Chemicals Corporation				
North Works, Wyandotte		November 1, 1966	April 1, 1968	Additional time is being requested to complete certain construction items on three of its eight waste outfalls to insure compliance with the suspended solids limitation. A conference has been scheduled for the May 28-29, 1968 Commission meeting to discuss the Company's proposal.
South Works, Wyandotte		November 1, 1966	April 1, 1968	Additional time is being requested to complete certain construction items on three of its eight waste outfalls to insure compliance with the suspended solids limitation. A conference has been scheduled for the May 28-29, 1968 Commission meeting to discuss the Company's proposal.

*Original Stipulation dates shown in parentheses with current compliance dates shown directly below the original.

APPENDIX B

WATER QUALITY STANDARDS
FOR
MICHIGAN WATERS

MICHIGAN'S INTERSTATE WATERS


CANADA
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MICHIGAN'S GREAT LAKES WATERS
INTERSTATE RIVER BASINS
MICHIGAN WATER RESOURCES COMMISSION
LAKE
HURON
LAKE
MICHIGAN
ST CLAIR RIVER
LAKE ST CLAIR
DETROIT RIVER
CANADA
LAKE
ERIE
WISCONSIN
ILLINOIS
ST JOSEPH RIVER
MAUMEE RIVER
INDIANA
OHIO

COMMISSION OBJECTIVE:

WATERS IN WHICH THE EXISTING QUALITY IS BETTER THAN THE ESTABLISHED STANDARDS ON THE DATE WHEN SUCH STANDARDS BECOME EFFECTIVE WILL NOT BE LOWERED IN QUALITY BY ACTION OF THE WATER RESOURCES COMMISSION UNLESS AND UNTIL IT HAS BEEN AFFIRMATIVELY DEMONSTRATED TO THE MICHIGAN WATER RESOURCES COMMISSION AND THE DEPARTMENT OF THE INTERIOR THAT THE CHANGE IN QUALITY WILL NOT BECOME INJURIOUS TO THE PUBLIC HEALTH, SAFETY, OR WELFARE, OR BECOME INJURIOUS TO DOMESTIC, COMMERCIAL, INDUSTRIAL, AGRICULTURAL, RECREATIONAL OR OTHER USES WHICH ARE BEING MADE OF SUCH WATERS, OR BECOME INJURIOUS TO THE VALUE OR UTILITY OF RIPARIAN LANDS; OR BECOME INJURIOUS TO LIVESTOCK, WILD ANIMALS, BIRDS, FISH, AQUATIC LIFE OR PLANTS, OR THE GROWTH OR PROPAGATION THEREOF BE PREVENTED OR INJURIOUSLY AFFECTED, OR WHEREBY THE VALUE OF FISH AND GAME MAY BE DESTROYED OR IMPAIRED, AND THAT SUCH LOWERING IN QUALITY WILL NOT BE UNREASONABLE AND AGAINST PUBLIC INTEREST IN VIEW OF THE EXISTING CONDITIONS IN ANY INTERSTATE WATERS OF MICHIGAN.

WATER WHICH DOES NOT MEET THE STANDARDS WILL BE IMPROVED TO MEET THE STANDARDS.

WATER

PARAMETERS / WATER USES	1 COLIFORM GROUP (organisms/100ml or MPN)	2 DISSOLVED OXYGEN (mg/l)	3 SUSPENDED, COLLOIDAL & SETTLEABLE MATERIALS	4 RESIDUES (Debris and material of unnatural origin and oils)	5 TOXIC & DELETERIOUS SUBSTANCES
A **WATER SUPPLY** (1) **DOMESTIC** Such as drinking, culinary and food processing.	For Great Lakes & Connecting Waters: The monthly average shall not exceed 2000 nor shall 20% of the samples examined exceed 2000. For Inland Waters: The monthly average shall not exceed 5000 nor shall 20% of the samples examined exceed 5000, nor exceed 20,000 in more than 5% of the samples.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating Solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Conform to current USPHS Drinking Water Standards except: Cyanide: Normally not detectable with a maximum upper limit of 0.2 mg/l. Chromium^{6}: Normally not detectable with a maximum upper limit of 0.05 mg/l. Phenol: Limitations as defined under A-8.
(2) **INDUSTRIAL** Such as cooling and manufacturing process.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Limited to concentrations less than those which are or may become injurious to the designated use.
B **RECREATION** (1) **TOTAL BODY CONTACT** Such as swimming, water skiing and skin diving.	The average of any series of 10 consecutive samples shall not exceed 1000 nor shall 20% of the samples examined exceed 5,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 100. See Appendix A, Section B.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Limited to concentrations less than those which are or may become injurious to the designated use.
(2.) **PARTIAL BODY CONTACT** Such as fishing, hunting, trapping and boating.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000. See Appendix A, Section B.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Limited to concentrations less than those which are or may become injurious to the designated use.
C **FISH, WILDLIFE AND OTHER AQUATIC LIFE** such as (growth and propagation)	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	At the average low river flow of 7-day duration expected to occur once in 10 years the following DO values shall be maintained for: Intolerant fish - cold water species: Not less than 6 at any time. Intolerant fish - warm water species: Average daily DO not less than 5, nor shall any single value be less than 4. Tolerant fish - warm water species: Average daily DO not less than 4, nor shall any single value be less than 3. At greater flows the DO shall be in excess of these values.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Not to exceed 1/10 of the 96-hour median tolerance limit obtained from continuous flow bio-assays where the dilution water and toxicant are continuously renewed except that other application factors may be used in specific cases when justified on the basis of available evidence and approved by the appropriate agency.
D **AGRICULTURAL** Such as livestock watering, irrigation and spraying.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Not less than 3 at any time.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Conform to current USPHS Drinking Water Standards as related to toxicants. Toxic and deleterious substances shall be less than those which are or may become injurious to the designated use.
E **COMMERCIAL** [illegible]	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Limited to concentrations less than those which are or may become injurious to the designated use.

✳ For the Great Lakes and connecting waters no heat load in sufficient quantity to create conditions which are or may become injurious to the public health, safety or welfare, or which are or may become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being or may be made of such waters; or which are or may become injurious to the value or utility of riparian lands, or which are or may become injurious to livestock, wild animals, birds, fish or aquatic life or the growth or propagation thereof.

QUALITY STANDARDS

TOTAL DISSOLVED SOLIDS 6 (mg/l)	NUTRIENTS 7 Phosphorus, ammonia, nitrates and sugars	TASTE & ODOR PRODUCING SUBSTANCES 8	TEMPERATURE✳ 9 (°F)	10 HYDROGEN ION (pH)	RADIOACTIVE MATERIALS 11
FOR GREAT LAKES & CONNECTING WATERS: Total Dissolved Solids: The maximum shall not exceed 200. Chlorides: The monthly average shall not exceed 50. A monthly average of 10 is a desirable limit where existing conditions are less than 10. **FOR INLAND WATERS:** Total Dissolved Solids: Shall not exceed 500 as a monthly average, nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 125.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent adverse effects on water treatment processes or the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use. Monthly average phenol concentration less than 0.002 mg/l - maximum concentration limited to 0.005 mg/l for a single sample.	The maximum natural water temperature shall not be increased by more than 10°F.	pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources.	An upper limit of 1000 picocuries/liter of gross beta activity (in absence of alpha emitters and Strontium-90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council.
Total Dissolved Solids: Shall not exceed 500 as a monthly average nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 125.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	The maximum natural water temperature shall not be increased by more than 10°F.	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	90°F maximum.	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	90°F maximum.	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Standards to be established when information becomes available on deleterious effects.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are causing or may cause taint in the flesh of fish or game.	Ambient / Allowable Increase / Maximum Limit Intolerant fish - cold water species: 32° to nat max / 10° / 70° Intolerant fish - warm water species: 32° to 35° / 15° /; 36° to nat max / 10° / 85° Tolerant fish - warm water species: 32° to 59° / 15° /; 60° to nat max / 10° / 87°	Maintained between 6.5 and 8.8 with a maximum artificially induced variation of 1.0 unit within this range. Changes in the pH of natural waters outside these values must be toward neutrality (7.0).	Standards to be established when information becomes available on deleterious effects.
Less than 700 dissolved minerals. Maximum percentage of sodium 40% as determined by the formula $\frac{(Na \times 100)}{(Na+Ca+Mg+K)}$ when the bases are expressed as milliequivalents per liter.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use. NO_3 concentrations shall conform to USPHS Drinking Water Standards.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	Not applicable	pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources.	An upper limit of 1000 picocuries/liter of gross beta activity (in absence of alpha emitters and Strontium-90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	The maximum natural water temperature shall not be increased by more than 10°F.	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.

DESIGNATED USE AREAS

The water quality standards for the designated use areas shall not apply during periods of authorized dredging for navigation purposes and during such periods of time when the after-effects of dredging degrade water quality in areas affected by dredging. (Water quality standardsfor the designated use area shall apply in areas affected by the disposal of spoil from dredging operations).

Where the waters are classified under more than one designated water use, it is intended that the most restrictive individual standard of the designated water uses shall be adhered to.

In areas adjacent to outfalls, standards for the designated water use or uses shall apply after admixture of waste effluents with the public waters but in no instance shall the mixing zone act as a barrier to fish migration or interfere unreasonably with the designated water use or uses for the area. The Water Resources Commission must have discretion in determining the extent of the mixing zone. In general, the Water Resources Commission encourages the use of outfall structures which minimize the extent of the mixing zone.

Based on their existing uses and reasonable future uses the waters of the St. Clair River, Lake St. Clair, Detroit River and Lake Erie will be protected as described below.

1. All the above named waters will be protected for Water Supply--Domestic, except that portion of the Detroit River from Point Hennepin to the mouth. The individual parameters shall be measured at the point of water withdrawal.

2. All the above named waters will be protected for Water Supply--Industrial. The individual parameters shall be measured at the point of water withdrawal.

3. All the above named waters, except at the mouths of tributaries, in the immediate vicinity of enclosed harbor areas and in the immediate vicinity of waste water treatment plant outfalls will be protected for Recreation--Total Body Contact; except for conditions relating to natural causes.

4. All the above named waters will be protected for Fish, Wildlife and Other Aquatic Life--Warm Water Sport Fish.

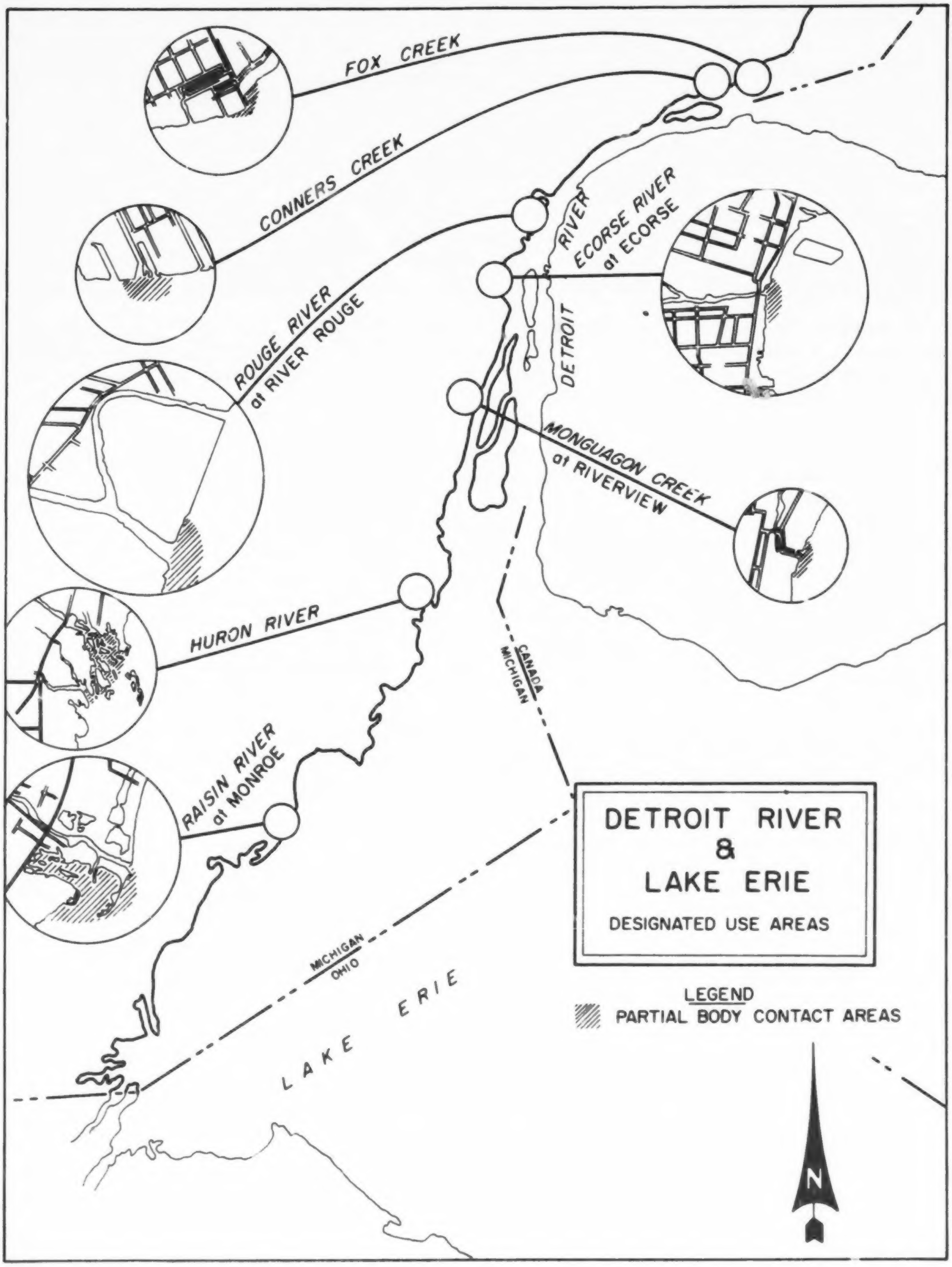
5. All the above named waters will be protected for Commercial Navigation in the designated navigation channels as maintained by the U. S. Corps of Engineers.

Based on their existing uses and reasonable future uses the Michigan waters of the Maumee River basin will be protected as described below.

1. All the above named waters will be protected for Recreation--Total Body Contact, except for conditions relating to natural causes.

2. All the above named waters will be protected for Fish, Wildlife and Other Aquatic Life--Warm Water Sport Fish.

3. All the above named waters will be protected for Agricultural Uses.


FOX CREEK
CONNERS CREEK
ECORSE RIVER at ECORSE
ROUGE RIVER at RIVER ROUGE
DETROIT RIVER
MONGUAGON CREEK at RIVERVIEW
HURON RIVER
CANADA
MICHIGAN
RAISIN RIVER at MONROE
DETROIT RIVER & LAKE ERIE
DESIGNATED USE AREAS
MICHIGAN
OHIO
LAKE ERIE
LEGEND
▨ PARTIAL BODY CONTACT AREAS
N

SUMMARY OF PROGRAM TO CONTROL AND ABATE POLLUTION

The Michigan Water Resources Commission, under the present water pollution control law (Act 245, Public Acts of 1929, as amended), has the authority to protect and conserve the water resources of the state and the Great Lakes, the power to make rules and regulations governing the same, and the power to prohibit the pollution of any waters of the state and Great Lakes.

Section 6 (B) of Act 245, Public Acts of 1929, as amended, makes the discharge of any raw sewage of human origin, directly or indirectly into any waters of the state, prima facie evidence of a violation of Section 6 (A) of the act unless said discharge shall have been permitted by an order, rule or regulation of the Commission.

It is the Commission's intent that the identified industrial waste problems be abated no later than June 1, 1970. Opportunity has been provided for the establishment of voluntary programs but if such programs have not been established by June 1, 1968, statutory proceedings will be initiated.

The existing municipal wastewater treatment plants in the basin have been listed in a preceding section. The surveillance program previously described will be implemented to the extent necessary to identify any existing inadequacies of treatment of dry weather flows by March 1, 1968. In those areas where noncompliance with the standards is determined to exist either by direct discharge or by discharge to tributaries which in turn flow to Lake Huron, a program will be established which will require, no later than June 1, 1972, treatment facilities adequate for meeting established water quality standards. Secondary treatment will be required as a minimum at all municipal wastewater treatment plants to meet the adopted water quality standards unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with present and proposed future water uses. Exception to the requirement for at least secondary treatment must be justified to the satisfaction of the Michigan Water Resources Commission and the Federal Water Pollution Control Administration. Year-round disinfection of all final effluents from sewage treatment plants is required. Industrial waste effluents will be required to meet the same effluent standards as municipal waste effluents. In those instances where in the opinion of the Commission it appears that a proposed voluntary program will not be successful or may not be accomplished within a reasonable period of time, statutory procedures will be initiated. Final Orders adopted by the Commission contain specific dates for approval of completed construction plans and specifications, awarding of construction contracts and commencing of construction, and the completion of construction and attainment of abatement. A typical time schedule requires the completion of construction plans within 12 months from the date of adoption of the Order, contract awards and construction start within 24 months, and construction completion and abatement within 36 to 42 months. The Commission is pursuing a program to secure abatement of presently identified discharges of raw sewage of human origin to public waters of the state no later than June 1, 1972 subject to conditions which are not within the control of the Commission.

It is the Commission's intent that new sewerage systems shall be developed on the basis of separate sewers for storm water and sanitary waste waters. When it is feasible, separated sanitary waste water systems shall not be discharged into existing combined systems. If such a discharge does occur, control facilities must be developed on the combined system so as to provide for water quality enhancement of the receiving waters commensurate with present and proposed future water uses and consistent with the requirements of the Water Resources Commission statute. The problems associated with the overflows of combined storm and sanitary waste waters from existing combined sewerage systems to public waters will be assessed as a part of the surveillance program identified in this report. In those areas where noncompliance with the standards is determined to exist as the result of overflows of sanitary waste water in storm runoff, a program will be established which will require, no later than June 1, 1977, the best practicable treatment or control.

It is the Commission's intent to require that nutrients in public waters, particularly with respect to phosphates, traceable to industrial or municipal waste sources be controlled. Persons proposing to make a new or increased use of waters of the state for waste disposal purposes will be required to utilize such technology and processes which are known. The long-term objective is to require that phosphates traceable to all industrial or municipal waste sources be controlled on or before June 1, 1977.

Soil Conservation Districts have been organized in every county within the basin. One of their primary objectives is to reduce land erosion. The State Soil Conservation Committee, the agency which provides leadership for the district programs, is a member of the Department of Agriculture. The Director of the Department of Agriculture is a member of the Water Resources Commission thus providing for the coordination of mutual objectives.

The Water Resources Commission has been directed by Governor Romney to develop rules and regulations, under the authority of Act 245, Public Acts of 1929, as amended, for control of the discharge of sanitary waste from recreational watercraft. The rules and regulations will be developed in cooperation and consultation with the Department of Public Health, the Waterways Commission, and other affected state agencies. They will be consistent with the Commission's statutory objectives of pollution control. Such rules and regulations should be adopted no later than June 1, 1968 and implemented no later than June 1, 1970, subject to such information as may be forthcoming at public hearings prior to the adoption of the rules and regulations and subject to budgetary requirements for enforcement.

In addition to the actions concerning existing problems, it is the Commission's intent to prevent future problems by continued implementation of Section 8 (B) of Act 245, Public Acts of 1929, as amended. This section reads as follows:

> "Any person requiring a new or substantial increase over and above the present use now made of the waters of the state for sewage or waste disposal purposes shall file with the commission a written statement setting forth the nature of the enterprise or development contemplated, the amount of water required to be used, its source, the proposed point of discharge of the wastes into the waters of the state, the estimated amount so to be discharged, and a fair statement setting forth the expected bacterial, physical, chemical and other known characteristics of the wastes. Within 60 days of receipt of

the statement, the commission shall make an order stating such minimum restrictions as in the judgment of the commission may be necessary to guard adequately against such unlawful uses of the waters of the state as are set forth in section 6. If the order is not acceptable to the user, he may request a hearing on the matter involved, following which the commission's final order of determination in this connection shall be conclusive unless reviewed in accordance with the provisions of the administrative procedures of Act No. 197 of the Public Acts of 1952, as amended, being sections 24.101 to 24.110 of the Compiled Laws of 1948, or any amendment thereto, in the circuit court of the county of Ingham, or for the county in which the user resides, or for the county in which the use is contemplated, upon petition therefor, filed within 15 days after service upon said user of the final order of determination."

Water treatment plant filter backwash discharges will be controlled under either Section 7 or Section 8 (B) of Act 245, P. A. 1929, as amended. A typical time schedule for correction of an existing problem under Section 7 would call for construction plans within 8 months from the date of the adoption of the Final Order, contract awards and construction start within 14 months, and construction completion and abatement within 24 months. Solids removal will be required as a minimum unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with proposed present and future water uses.

The criteria and plan of implementation are consistent with the recommendations of all Federal enforcement conferences to which the State has been a party.

The Commission has as an objective the following:

> "Waters in which the existing quality is better than the established standards on the date when such standards become effective will not be lowered in quality by action of the Water Resources Commission unless and until it has been affirmatively demonstrated to the Michigan Water Resources Commission and the Department of the Interior that the change in quality will not become injurious to the public health, safety, or welfare, or become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being made of such waters, or become injurious to the value or utility of riparian lands; or become injurious to livestock, wild animals, birds, fish, aquatic life or plants, or the growth or propagation thereof be prevented or injuriously affected; or whereby the value of fish and game may be destroyed or impaired, and that such lowering in quality will not be unreasonable and against public interest in view of the existing conditions in any interstate waters of Michigan.
>
> "Water which does not meet the standards will be improved to meet the standards."

APPENDIX C

WATERCRAFT POLLUTION CONTROL ACT

DEPARTMENT OF CONSERVATION

WATER RESOURCES COMMISSION

POLLUTION FROM WATERCRAFT

Filed with Secretary of State,

(By authority conferred on the water resources commission by sections 2 and 5 of Act No. 245 of the Public Acts of 1929, as amended, being sections 323.2 and 323.5 of the Compiled Laws of 1948.)

R 323.501. Definitions.

Rule 501. (1) "Act" means Act No. 245 of the Public Acts of 1929, as amended, being sections 323.1 to 323.12a of the Compiled Laws of 1948, and the act which these rules implement.

(2) "Commission" means the Water Resources Commission of the Department of Conservation.

(3) "Litter" means bottles, glass, crockery, cans, scrap metal, junk, paper, plastic, garbage, rubbish or similar refuse discarded as no longer useful or usable.

(4) "Marine toilet" means a toilet on or in a watercraft.

(5) "Nonpollutional" means incapable of causing unlawful pollution as defined in section 6 of the act, as amended.

(6) "Sewage" means human body wastes, treated or untreated.

(7) "Watercraft" means a contrivance used or capable of being used for navigation upon water whether or not capable of self-propulsion, except a passenger or cargo-carrying vessel including those subject to the Interstate Quarantine Regulations of the United States Public Health Service adopted pursuant to sections 241, 243, 252 and 262 to 272 of Title 42 of the United States Code.

R 323.502. Sewage; use of pollution control devices and disposal facilities.

Rule 502. (1) No person shall operate a marine toilet on a watercraft on the waters of this state so as to discharge sewage into such waters unless the sewage has been rendered nonpollutional by passage through a device approved by the commission.

(2) No person owning or operating a watercraft having a marine toilet shall use or permit the use of such toilet on the waters of this state unless the toilet is equipped with 1 of the following pollution control devices:

(a) A holding tank which will retain all sewage produced on the watercraft.

(b) An incinerating device which will reduce to ash all sewage produced on the watercraft.

(c) A device determined by the commission to be capable of rendering the sewage discharges nonpollutional in accordance with the requirements of the act.

(3) No person shall dispose of sewage accumulated in a holding tank or any other container on a watercraft in such manner that the sewage reaches or may reach the waters of this state except through a sewage disposal facility approved by the state Department of Public Health or its designated representative.

R 323.503. Watercraft registration; marine toilet information.

Rule 503. An applicant for a certificate of number for a watercraft pursuant to section 33 of Act No. 303 of the Public Acts of 1967, being section 281.1033 of the Compiled Laws of 1948, shall disclose at such time to the commission whether the watercraft has in or on it a marine toilet, and if so, whether the toilet is equipped with a pollution control device as required by these rules. The commission may request the secretary of state to provide it with the name of an applicant whose application indicates the absence of such pollution control device on a marine toilet.

R 323.504. Litter disposal.

Rule 504. Disposal of litter is subject to the provisions of Act No. 106 of the Public Acts of 1963, as amended, being sections 752.901 to 752.906 of the Compiled Laws of 1948.

R 323.509. Effective date.

Rule 509. These rules are effective January 1, 1970.

further set down the effluent restrictions and treatment facility construction time schedules required to achieve the desired water quality goals. Finally, the reports described the water quality surveillance and effluent monitoring programs that have been established by the Michigan Water Resources Commission.

This report will review the compliance status of the previously approved abatement programs and time schedules and will present information on recent pollution control activities affecting water quality in Michigan waters of Lake Erie.

Industrial and Municipal Compliance Status

Appendix A summarizes the performance status of the 25 industrial plants and 11 municipal governmental units having stipulations with the Water Resources Commission to control the polluting content of their waste discharges to the Detroit River and Lake Erie. In three cases out of eleven, municipal performance schedules have been modified to accommodate expanded waste control projects, and four industrial schedules have been modified to allow for unforeseen construction delays. The four paper mills in the Monroe area have decided to join the metropolitan waste treatment system and their compliance dates are now considered to be the same as for the city of Monroe. Even under the revised performance schedules, all municipalities and industries are scheduled to have treatment facilities in operation by December 1, 1970. Six industries have waste control facilities in operation and are meeting the stipulated effluent restrictions. One municipality and three industrial plants have not met the provisions of recent performance dates and each will be reviewed by the Water Resources Commission at an early date.

Water Quality Standards

Since the 1967 reconvened conference, Michigan has adopted water quality standards for all interstate waters, including Michigan waters of Lake Erie, along with designated use areas and a plan of implementation. The standards, use areas and plan of implementation have been approved by the Secretary of the Interior with the single exception of a part of the temperature standards. This program data is detailed in Appendix B. Michigan is also proceeding with a program to develop comparable water quality standards. I might add that this program will be completed on January 1, 1969.

Watercraft Pollution Control

The Water Resources Commission was directed by Governor Romney to develop rules and regulations for the control of sanitary waste discharges from recreational watercraft. The rule was developed in cooperation with the Department of Health, the Waterways Commission and other affected State agencies; and in consultation with neighboring States and the Province of Ontario. The rule is designed for application to all watercraft equipped with a marine toilet, with the exception of passenger or cargo-carrying vessels subject to the Interstate Quarantine Regulations of the United States Public Health Service. The rule requires that after January 1, 1970, all watercraft having a marine toilet must be provided with either a holding tank, a sewage incincerator or a device which has been determined by the Commission to be capable of rendering the sewage discharges non-pollutional. (See Appendix C.)

Water Quality Surveillance of the Michigan Waters of Lake Erie and Its Tributaries

The water quality surveillance program established by Michigan was described in detail to the conferees at Buffalo in 1967. The sampling and testing of the Detroit River and Lake Erie at 63 locations is continuing and the data obtained during 1966 and 1967 have been tabulated in Appendix D. Similar data for the 75 municipal and industrial waste discharges along the Detroit, Rouge, Huron and Raisin Rivers is shown in Appendix E.

APPENDIX A

INDUSTRIAL AND MUNICIPAL PERFORMANCE STATUS

DETROIT RIVER-LAKE ERIE GOVERNMENTAL UNIT STIPULATION DATES FOR COMPLIANCE

Unit	Preliminary Engineering Study and Basis of Design	Approval of Construction Plans and Specifications	Complete Construction	Comments
Berlin Township	May 1, 1967	May 1, 1968	May 1, 1969	Preliminary design and report completed. Township has notified the Commission that it has been unable to proceed with final plans due to financing problems. Commission will review problem at an early date.
Frenchtown Township	May 1, 1967	(May 1, 1968)* November 30, 1968	(May 1, 1969) December 1, 1970	Township has joined the Monroe metropolitan system with treatment of wastes at the City plant. New compliance dates were recently approved due to expanded service area and coordination with the metropolitan treatment plant improvement construction schedule.
Monroe Township	May 1, 1967	(May 1, 1968) November 1, 1968	(May 1, 1969) May 1, 1970	Township has joined the Monroe metropolitan system with treatment of wastes at the City plant. New compliance dates were recently approved due to expanded service area and coordination with the metropolitan treatment plant improvement construction schedule.
Grosse Ile Township	April 1, 1967	November 1, 1968	November 1, 1970	Preliminary plans approved. In compliance.
Wayne County	April 1, 1967	November 1, 1968	November 1, 1970	Preliminary plans approved. In compliance.
City of Detroit	April 1, 1967	November 1, 1968	November 1, 1970	City was also to submit a report on combined sewer overflow control by April 1, 1968. The report has been received and approved. City is in compliance.
Village of Estral Beach	May 1, 1967	May 1, 1968	May 1, 1969	Preliminary engineering study report was received and approved timely. Due to the estimated high per capita cost of the proposed municipal system, the village elected to upgrade individual disposal systems. Notification has been received from the Village and the Monroe County Health Department that complete abatement has been achieved. Confirmation studies by Commission staff have been scheduled.
City of Luna Pier	May 1, 1967	May 1, 1968	May 1, 1969	Final plans approved. In compliance.
City of Monroe	May 1, 1967	(May 1, 1968) November 1, 1968	(May 1, 1969) December 1, 1970	Contractual agreements have been reached with the three Monroe area paper companies and two adjoining townships for joint waste treatment in the City's plant. Compliance dates were recently modified due to the expanded scope of the collection and treatment project.
City of Riverview	April 1, 1967	November 1, 1968	November 1, 1970	Preliminary plans approved. In compliance.
City of Trenton	April 1, 1968	November 1, 1969	November 1, 1970	Preliminary plans approved. In compliance.

*Original Stipulation dates shown in parentheses with current compliance dates shown directly below the original.

DETROIT RIVER-LAKE ERIE INDUSTRY STIPULATION DATES FOR COMPLIANCE

Industry	Preliminary Engineering Study and Basis of Design	Approval of Construction Plans and Specifications	Complete Construction	Comments
Allied Chemical Corporation				
Semet Solvay Division, Detroit		April 1, [illegible]	April 1, [illegible]	Facilities in operation. In compliance.
Solvay Process Division, Detroit		November 1, [illegible]	April 1, [illegible]	The Company will cease operations at this location as of January 1, [illegible]. Action on the Company's request for this extension is pending.
American Cement Corporation				
Peerless Cement Division, Detroit		May 1, [illegible]	May 1, [illegible]	Facilities in operation. Monitor sampling shows the Company to be near compliance. Additional studies are presently being undertaken by the Company.
Consolidated Packaging Corporation				
North Side Plant, Monroe	January 1, [illegible]	[illegible] 1, [illegible]* November 1, [illegible]	[illegible] 1, [illegible] December 1, [illegible]	The Company has entered into a contract for secondary treatment of wastes in the Monroe municipal metropolitan treatment plant. Compliance dates are now deemed to be the same as for the City of Monroe.
South Side Plant, Monroe	January 1, 1967	[illegible] 1, [illegible] November 1, [illegible]	[illegible] 1, [illegible] December 1, [illegible]	The Company has entered into a contract for secondary treatment of wastes in the Monroe municipal metropolitan treatment plant. Compliance dates are now deemed to be the same as for the City of Monroe.
Darling and Company, Melvindale		November 1, [illegible]	[illegible] 1, [illegible] September 1, [illegible]	Considerable waste reduction has been accomplished through in-plant changes. A program of equipment conversion is now underway which, when complete, will produce an effluent much better than required under the stipulation. Construction of an interim aerated lagoon is also underway which will provide near compliance by June [illegible]. A final compliance date modification was granted by the Commission in [illegible] [illegible] to facilitate the plant conversion program.
E. I. duPont deNemours and Company, Inc.				
Industrial and Biochemical Division, Ecorse		April 1, [illegible]	[illegible]	Facilities in operation. Partial compliance achieved. Operations at this location will cease [illegible] 31, [illegible].
Firestone Tire and Rubber Company				
Firestone Steel Products Division, Riverview		November 1, [illegible]	November 1, [illegible]	The Company has entered into a contract for the hauling away and disposition of all the spent pickle liquor and no longer discharges this material to the Detroit River.
Ford Motor Company				
Monroe Plant		December 1, [illegible]	(+[illegible] months) February 15, [illegible]	Construction plans were submitted timely and approved February 15, [illegible] thereby establishing the firm construction completion date shown.
Rouge Plant other than iron and suspended solids		October 1, [illegible]	(+[illegible] months) [illegible] 1, [illegible]	Construction plans have been approved. Additional [illegible] months construction time was granted due to change in the scope of the construction project for [illegible] treatment. [illegible] facilities are substantially complete except for construction of holding ponds that require coordination with [illegible] [illegible] Engineers, Rouge River improvement project. [illegible] extension of time has been requested to [illegible] 1, [illegible].
Iron		March 1, [illegible]	(+24 months) April [illegible], [illegible]	Conversion to hydrochloric acid steel pickling lines with all spent pickle liquor returned to supplier is expected to eliminate all iron discharges [illegible]
suspended solids		March 1, 1967	(+27 months) June 1, 1969	Plans received and approved timely.

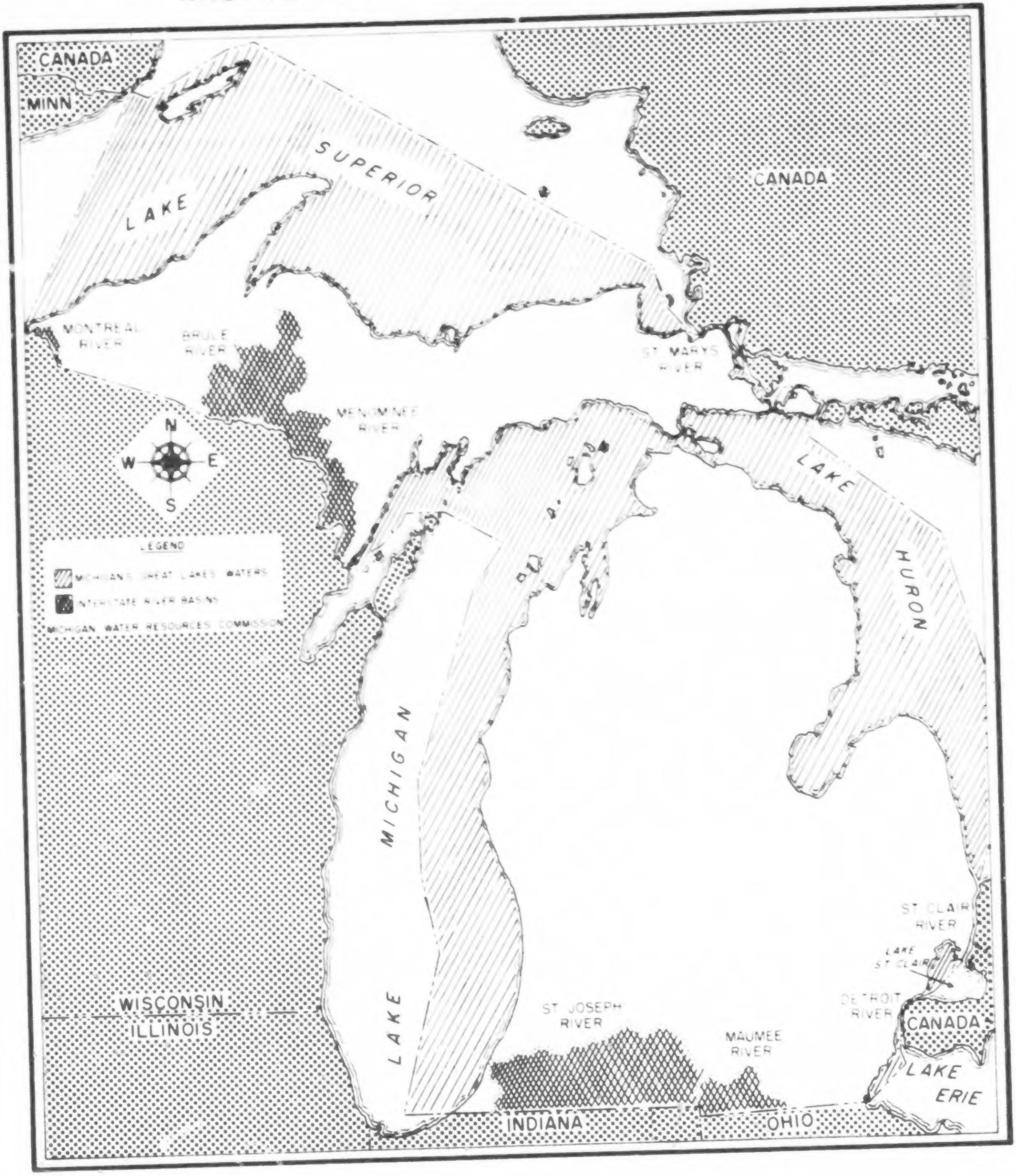
Great Lakes Steel Corporation				
80" Hot Strip Mill, Ecorse		November 1, 1966	April 1, 1968	Facilities in operation and in compliance.
Steel Rolling Mill, Ecorse other than acid and iron		November 1, 1966	April 1, 1968	Facilities in operation and in compliance.
other than acid and iron, No. 3 slabbing mill		October 1, 1967	October 1, 1968	Plans approved, facilities under construction.
acid and iron	April 1, 1967	December 1, 1967	April 1, 1969	Construction plans were submitted and approved timely.
Blast Furnace, River Rouge		November 1, 1966	April 1, 1968	Partial compliance obtained. Oil and suspended solids still exceed limits in some outlets. Additional improvements being made by Company which are expected to result in compliance.
McLouth Steel Corporation, Trenton		November 1, 1966	April 1, 1968	Facilities in operation and in compliance.
Mobil Oil Company, Trenton		November 1, 1966	November 1, 1967	Facilities in operation. Company is slightly in excess of oil concentration limits and has plans for additional treatment lagoons.
Monsanto Company				
Trenton Plant	November 1, 1967	August 1, 1968	November 1, 1969	Plans have been approved, construction has been completed and facilities are in operation.
Trenton Resins Plant	(November 1, 1966) September 1, 1967	(April 1, 1967) December 1, 1967	(April 1, 1968) September 1, 1968	Compliance dates were revised to allow for additional plant studies. Plans have been submitted and approved timely. Construction underway.
Pennsalt Chemicals Corporation				
East Plant, Wyandotte		November 1, 1966	April 1, 1968	In compliance.
West Plant, Riverview		November 1, 1966	April 1, 1968	Not in compliance. Commission will review the problem at an early date.
Revere Copper and Brass, Inc., Detroit		November 1, 1966	November 1, 1967	Facilities have been installed. Compliance not fully established. Commission will review the problem at an early date.
Scott Paper Company, Detroit for BOD	January 1, 1968	January 1, 1969	January 1, 1970	Preliminary plans received and approved timely.
for solids		May 1, 1967	(May 1, 1968) August 19, 1968	Facilities under construction.
Time Container Corporation				
Monroe Paper Products Division	January 1, 1967	(January 1, 1968) November 1, 1968	(January 1, 1969) December 1, 1970	The Company has entered into a contract for secondary treatment of wastes in the Monroe municipal metropolitan treatment plant. Compliance dates are now deemed to be the same as for the City of Monroe.
Union Camp Corporation, Monroe	January 1, 1967	(January 1, 1968) November 1, 1968	(January 1, 1969) December 1, 1970	The Company has entered into a contract for secondary treatment of wastes in the Monroe municipal metropolitan treatment plant. Compliance dates are now deemed to be the same as for the City of Monroe.
Wyandotte Chemicals Corporation				
North Works, Wyandotte		November 1, 1966	April 1, 1968	Additional time is being requested to complete certain construction items on three of its eight waste outfalls to insure compliance with the suspended solids limitation. A conference has been scheduled for the May 28-29, 1968 Commission meeting to discuss the Company's proposal.
South Works, Wyandotte		November 1, 1966	April 1, 1968	Additional time is being requested to complete certain construction items on three of its eight waste outfalls to insure compliance with the suspended solids limitation. A conference has been scheduled for the May 28-29, 1968 Commission meeting to discuss the Company's proposal.

*Original Stipulation dates shown in parentheses with current compliance dates shown directly below the original.

APPENDIX B

WATER QUALITY STANDARDS
FOR
MICHIGAN WATERS

MICHIGAN'S INTERSTATE WATERS


CANADA
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MICHIGAN'S GREAT LAKES WATERS
INTERSTATE RIVER BASINS
MICHIGAN WATER RESOURCES COMMISSION
LAKE HURON
LAKE MICHIGAN
ST CLAIR RIVER
LAKE ST CLAIR
DETROIT RIVER
CANADA
WISCONSIN
ILLINOIS
ST JOSEPH RIVER
MAUMEE RIVER
LAKE ERIE
INDIANA
OHIO

COMMISSION OBJECTIVE:
WATERS IN WHICH THE EXISTING QUALITY IS BETTER THAN THE ESTABLISHED STANDARDS ON THE DATE WHEN SUCH STANDARDS BECOME EFFECTIVE WILL NOT BE LOWERED IN QUALITY BY ACTION OF THE WATER RESOURCES COMMISSION UNLESS AND UNTIL IT HAS BEEN AFFIRMATIVELY DEMONSTRATED TO THE MICHIGAN WATER RESOURCES COMMISSION AND THE DEPARTMENT OF THE INTERIOR THAT THE CHANGE IN QUALITY WILL NOT BECOME INJURIOUS TO THE PUBLIC HEALTH, SAFETY, OR WELFARE, OR BECOME INJURIOUS TO DOMESTIC, COMMERCIAL, INDUSTRIAL, AGRICULTURAL, RECREATIONAL OR OTHER USES WHICH ARE BEING MADE OF SUCH WATERS, OR BECOME INJURIOUS TO THE VALUE OR UTILITY OF RIPARIAN LANDS, OR BECOME INJURIOUS TO LIVESTOCK, WILD ANIMALS, BIRDS, FISH, AQUATIC LIFE OR PLANTS, OR THE GROWTH OR PROPAGATION THEREOF BE PREVENTED OR INJURIOUSLY AFFECTED, OR WHEREBY THE VALUE OF FISH AND GAME MAY BE DESTROYED OR IMPAIRED, AND THAT SUCH LOWERING IN QUALITY WILL NOT BE UNREASONABLE AND AGAINST PUBLIC INTEREST IN VIEW OF THE EXISTING CONDITIONS IN ANY INTERSTATE WATERS OF MICHIGAN.
WATER WHICH DOES NOT MEET THE STANDARDS WILL BE IMPROVED TO MEET THE STANDARDS.

WATER

PARAMETERS / WATER USES	COLIFORM GROUP 1 (Coliform/100ml by MPN)	DISSOLVED OXYGEN 2 (mg/l)	SUSPENDED, COLLOIDAL & SETTLEABLE MATERIALS 3	RESIDUES 4 [illegible] and material of unnatural origin [illegible]	TOXIC & DELETERIOUS SUBSTANCES 5
A **WATER SUPPLY** (1) **DOMESTIC** Such as drinking, culinary and food processing.	For Great Lakes & Connecting waters: The monthly average shall not exceed 2000 nor shall 20% of the samples examined exceed 2000. For inland waters: The monthly average shall not exceed 5000 nor shall 20% of the samples examined exceed 5000, nor exceed 20,000 in more than 5% of the samples.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating Solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Conform to current USPHS Drinking Water Standards except: Cyanide: Normally not detectable with a maximum upper limit of 0.2 mg/l. Chromium: Normally not detectable with a maximum upper limit of 0.05 mg/l. Phenol: Limitations as defined under F-B.
(2) **INDUSTRIAL** Such as cooling and manufacturing processes.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Limited to concentrations less than those which are or may become injurious to the designated use.
B **RECREATION** (1) **TOTAL BODY CONTACT** Such as swimming, water skiing and skin diving.	The average of any series of 10 consecutive samples shall not exceed 1000 nor shall 20% of the samples examined exceed 2,400. The average fecal coliform density for the same 10 consecutive samples shall not exceed 200. See Appendix A, Section B.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Limited to concentrations less than those which are or may become injurious to the designated use.
(2) **PARTIAL BODY CONTACT** Such as fishing, hunting, trapping and boating.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000. See Appendix A, Section B.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Limited to concentrations less than those which are or may become injurious to the designated use.
C **FISH, WILDLIFE AND OTHER AQUATIC LIFE** Such as growth and propagation.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	At the average low flow of 7-day duration expected to occur once in 10 years the following DO values shall be maintained: Intolerant fish - cold water species: Not less than 6 at any time. Intolerant fish - warm water species: Average daily DO not less than 5, nor shall any single value be less than 4. Tolerant fish - warm water species: Average daily DO not less than 4, nor shall any single value be less than 3. At greater flows the DO shall be in excess of these values.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Not to exceed 1/10 of the 96-hour median tolerance limit obtained from continuous flow bioassays where the dilution water and toxicant are continuously renewed except that other application factors may be used in specific cases when justified on the basis of available evidence and approved by the appropriate agency.
D **AGRICULTURAL** Such as livestock watering, irrigation and spraying.	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Not less than 3 at any time.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Conform to current USPHS Drinking Water Standards as related to the animals. Toxic and deleterious substances shall be less than those which are or may become injurious to the designated use.
E **COMMERCIAL** [illegible]	The average of any series of 10 consecutive samples shall not exceed 5000 nor shall 20% of the samples examined exceed 10,000. The average fecal coliform density for the same 10 consecutive samples shall not exceed 1000.	Present at all times in sufficient quantities to prevent nuisance.	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with the designated use.	Floating solids: None of unnatural origin. Residues: No evidence of such material except of natural origin. No visible film of oil, gasoline or related materials. No globules of grease.	Limited to concentrations less than those which are or may become injurious to the designated use.

QUALITY STANDARDS

TOTAL DISSOLVED SOLIDS (mg/l) 6	NUTRIENTS 7 Phosphorus, ammonia, nitrates and sugars	TASTE & ODOR PRODUCING SUBSTANCES 8	TEMPERATURE* (°F) 9	HYDROGEN ION (pH) 10	RADIOACTIVE MATERIALS 11
FOR GREAT LAKES & CONNECTING WATERS: Total Dissolved Solids: The maximum shall not exceed 200. Chlorides: The monthly average shall not exceed 50. A monthly average of 10 is a desirable limit where existing conditions are less than 10. **FOR INLAND WATERS:** Total Dissolved Solids: Shall not exceed 500 as a monthly average, nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 125.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent adverse effects on water treatment processes or the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use. Monthly average phenol concentration less than 0.002 mg/l - maximum concentration limited to 0.005 mg/l for a single sample.	The maximum natural water temperature shall not be increased by more than 10°F.	pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources.	An upper limit of 1000 picocuries/liter of gross beta activity (in absence of alpha emitters and Strontium-90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council.
Total Dissolved Solids: Shall not exceed 500 as a monthly average nor exceed 750 at any time. Chlorides: The monthly average shall not exceed 125.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	The maximum natural water temperature shall not be increased by more than 10°F.	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	90°F maximum.	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	90°F maximum.	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.
Standards to be established when information becomes available on deleterious effects.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are causing or may cause taint in the flesh of fish or game.	Ambient / Allowable increase / Maximum limit Intolerant fish - cold water species: 32° to nat max / 10° / 70° Intolerant fish - warm water species: 32° to 35° / 15° 36° to nat max / 10° / 85° Tolerant fish - warm water species: 32° to 59° / 15° 60° to nat max. / 10° / 87°	Maintained between 6.5 and 8.8 with a maximum artificially induced variation of 1.0 unit within this range. Changes in the pH of natural waters outside these values must be toward neutrality (7.0).	Standards to be established when information becomes available on deleterious effects.
Less than 700 dissolved minerals. Maximum percentage of sodium 40% as determined by the formula $\frac{(Na \times 100)}{(Na+Ca+Mg+k)}$ when the bases are expressed as milliequivalents per liter.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use. NO_3 concentrations shall conform to USPHS Drinking Water Standards.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	Not applicable	pH shall not have an induced variation of more than 0.5 unit as a result of unnatural sources.	An upper limit of 1000 picocuries/liter of gross beta activity (in absence of alpha emitters and Strontium-90). If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposures above the recommended limits established by the Federal Radiation Council.
Limited to concentrations less than those which are or may become injurious to the designated use.	Nutrients originating from industrial, municipal, or domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use.	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use.	The maximum natural water temperature shall not be increased by more than 10°F.	Maintained within the range 6.5-8.8 with a maximum induced variation of 0.5 unit within this range.	Standards to be established when information becomes available on deleterious effects.

* For the Great Lakes and connecting waters no heat load in sufficient quantity to create conditions which are or may become injurious to the public health, safety or welfare; or which are or may become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being or may be made of such waters; or which are or may become injurious to the value or utility of riparian lands; or which are or may become injurious to livestock, wild animals, birds, fish or aquatic life or the growth or propagation thereof.

Designated Use Areas

The water quality standards for the designated use areas shall not apply during periods of authorized dredging for navigation purposes and during such periods of time when the after effects of dredging degrade water quality in areas affected by dredging. (Water quality standards for the designated use area shall apply in areas affected by the disposal of spoil from dredging operations.)

Where the waters are classified under more than one designated water use, it is intended that the most restrictive individual standard of the designated water uses shall be adhered to.

In areas adjacent to outfalls, standards for the designated water use or uses shall apply after admixture of waste effluents with the public waters but in no instance shall the mixing zone act as a barrier to fish migration or interfere unreasonably with the designated water use or uses for the area. The Water Resources Commission must have discretion in determining the extent of the mixing zone. In general, the Water Resources Commission encourages the use of outfall structures which minimize the extent of the mixing zone.

Based on their existing uses and reasonable future uses the waters of the St. Clair River, Lake St.

Clair, Detroit River and Lake Erie will be protected as described below.

1. All the above named waters will be protected for Water Supply-Domestic, except that portion of the Detroit River from Point Hennepin to the mouth. The individual parameters shall be measured at the point of water withdrawal.

2. All the above named waters will be protected for Water Supply-Industrial. The individual parameters shall be measured at the point of water withdrawal.

3. All the above named waters, except at the mouths of tributaries, in the immediate vicinity of enclosed harbor areas and in the immediate vicinity of wastewater treatment plant outfalls will be protected for Recreation-Total Body Contact; except for conditions relating to natural causes.

4. All the above named waters will be protected for Fish, Wildlife and Other Aquatic Life-Warm Water Sport Fish.

5. All the above named waters will be protected for Commercial Navigation in the designated navigation channels as maintained by the United States Corps of Engineers.

Based on their existing uses and reasonable future uses, the Michigan waters of the Maumee River Basin will be protected as described below.

1. All the above named waters will be protected for Recreation-Total Body Contact, except for conditions relating to natural causes.

2. All the above named waters will be protected for Fish, Wildlife and Other Aquatic Life-Warm Water Sport Fish.

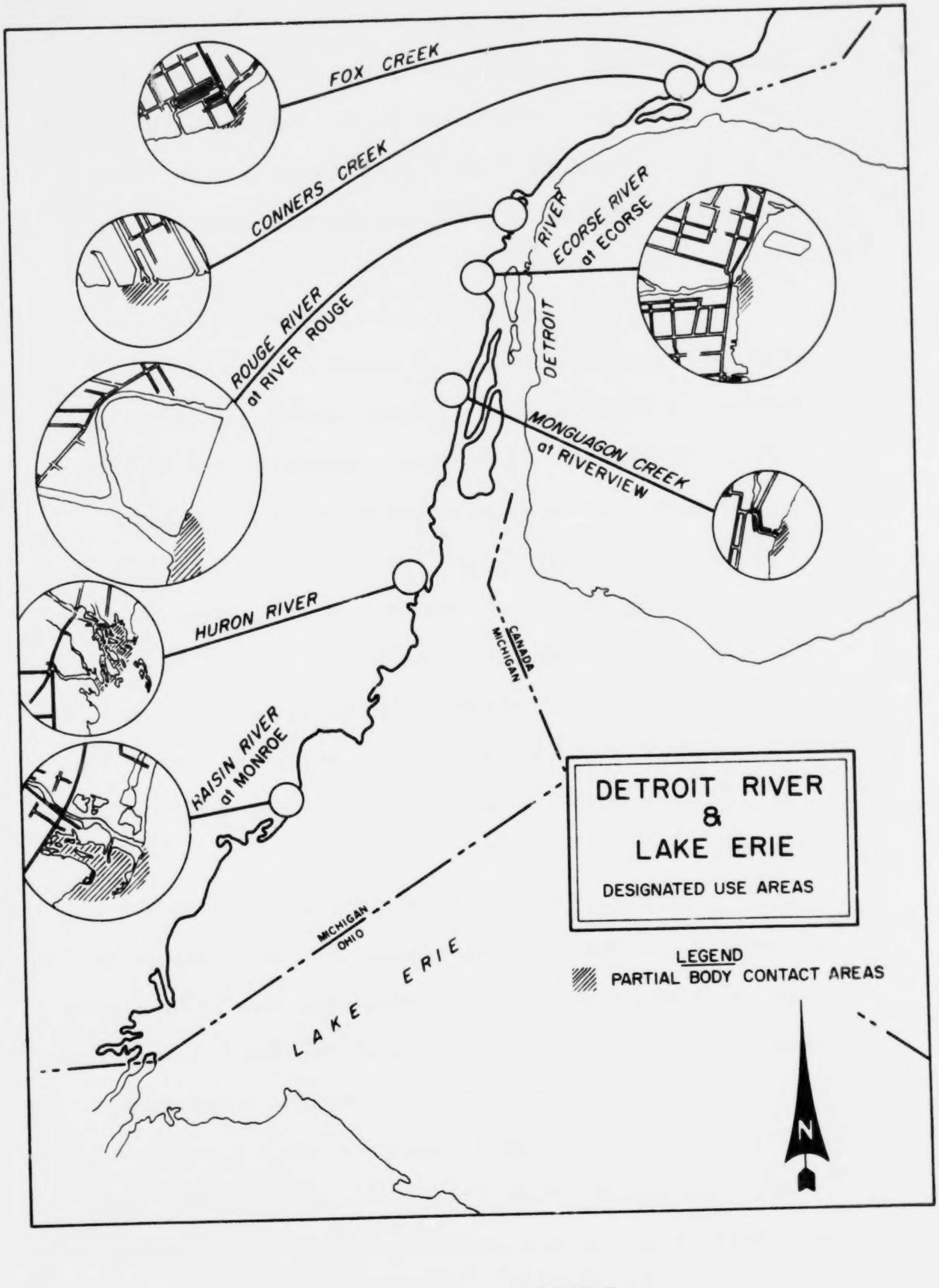
3. All the above named waters will be protected for Agricultural Uses.

Summary of Program to Control and Abate Pollution

The Michigan Water Resources Commission, under the present water pollution control law (Act 245, Public Acts of 1929, as amended), has the authority to protect and conserve the water resources of the State and the Great Lakes, the power to make rules and regulations governing the same, and the power to prohibit the pollution of any waters of the State and Great Lakes.

Section 6 (B) of Act 245, Public Acts of 1929, as amended, makes the discharge of any raw sewage of human origin, directly or indirectly into any waters of the State, prima facie evidence of a violation of Section 6 (A) of the act unless said discharge shall have been permitted by an order, rule or regulation of the Commission.

It is the Commission's intent that the identified


FOX CREEK
CONNERS CREEK
ROUGE RIVER at RIVER ROUGE
ECORSE RIVER at ECORSE
DETROIT RIVER
MONGUAGON CREEK at RIVERVIEW
HURON RIVER
RAISIN RIVER at MONROE
CANADA
MICHIGAN
MICHIGAN
OHIO
LAKE ERIE
DETROIT RIVER & LAKE ERIE
DESIGNATED USE AREAS
LEGEND
▨ PARTIAL BODY CONTACT AREAS
N

industrial waste problems be abated no later than June 1, 1970. Opportunity has been provided for the establishment of voluntary programs but if such programs have not been established by June 1, 1968, statutory proceedings will be initiated.

The existing municipal wastewater treatment plants in the basin have been listed in a preceding section. The surveillance program previously described will be implemented to the extent necessary to identify any existing inadequacies of treatment of dry weather flows by March 1, 1968. In those areas where noncompliance with the standards is determined to exist either by direct discharge or by discharge to tributaries which in turn flow to Lake Huron, a program will be established which will require, no later than June 1, 1972, treatment facilities adequate for meeting established water quality standards.

Secondary treatment will be required as a minimum at all municipal wastewater treatment plants to meet the adopted water quality standards unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with present and proposed future water uses. Exception to the requirement for at least secondary treatment must be justified to the satisfaction of the Michigan Water

Resources Commission and the Federal Water Pollution Control Administration. Year-round disinfection of all final effluents from sewage treatment plants is required. Industrial waste effluents will be required to meet the same effluent standards as municipal waste effluents. In those instances where in the opinion of the Commission it appears that a proposed voluntary program will not be successful or may not be accomplished within a reasonable period of time, statutory procedures will be initiated.

Final Orders adopted by the Commission contain specific dates for approval of completed construction plans and specifications, awarding of construction contracts and commencing of construction, and the completion of construction and attainment of abatement. A typical time schedule requires the completion of construction plans within twelve months from the date of adoption of the Order, contract awards and construction start within twenty-four months, and construction completion and abatement within thirty-six to forty-two months. The Commission is pursuing a program to secure abatement of presently identified discharges of raw sewage of human origin to public waters of the State no later than June 1, 1972, subject to conditions which are not within the control of the Commission.

It is the Commission's intent that new sewerage systems shall be developed on the basis of separate sewers for stormwater and sanitary wastewaters. When it is feasible, separated sanitary wastewater systems shall not be discharged into existing combined systems. If such a discharge does occur, control facilities must be developed on the combined system so as to provide for water quality enhancement of the receiving waters commensurate with present and proposed furutre water uses and consistent with the requirements of the Water Resources Commission statute. The problems associated with the overflows of combined storm and sanitary wastewaters from existing combined sewerage systems to public waters will be assessed as a part of the surveillance program identified in this report. In those areas where noncompliance with the standards is determined to exist as the result of overflows of sanitary wastewater in storm runoff, a program will be established which will require, no later than June 1, 1977, the best practicable treatment or control.

It is the Commission's intent to require that nutrients in public waters, particularly with respect to phosphates, traceable to industrial or municipal waste sources be controlled. Persons proposing to make a new or increased use of waters of the State for waste disposal purposes will be required to utilize such technology and processes which are known. The long-term objective is to require that phosphates traceable to all industrial or municipal waste sources be controlled on or before June 1, 1977.

Soil Conservation Districts have been organized in every county within the basin. One of their primary objectives is to reduce land erosion. The State Soil Conservation Committee, the agency which provides leadership for the district programs, is a member of the Department of Agriculture. The Director of the Department of Agriculture is a member of the Water Resources Commission thus providing for the coordination of mutual objectives.

The Water Resources Commission has been directed by Governor Romney to develop rules and regulations, under the authority of Act 245, Public Acts of 1929, as amended, for control of the discharge of sanitary waste from recreational watercraft. The rules and regulations will be developed in cooperation and consultation with the Department of Public Health, the Waterways Commission, and other affected state agencies. They will be consistent with the Commission's statutory objectives of pollution control. Such rules and regulations should be adopted no later than June 1, 1968 and implemented no later than June 1, 1970, subject to such information as may be forthcoming at public hearings prior to the adoption of the rules and regulations and subject to budgetary requirements for enforcement.

In addition to the actions concerning existing problems, it is the Commission's intent to prevent future problems by continued implementation of Section 8 (B) of Act 245, Public Acts of 1929, as amended. This section reads as follows:

"Any person requiring a new or substantial increase over and above the present use now made of the waters of the state for sewage or waste disposal purposes shall file with the Commission a written statement setting forth the nature of the enterprise or development contemplated, the amount of water required to be used, its source, the proposed point of discharge of the wastes into the waters of the state, the estimated amount so to be discharged, and a fair statement setting forth the expected bacterial, physical, chemical and other known characteristics of the wastes. Within sixty days of receipt of the statement, the Commission shall make an order stating such minimum restrictions as in the judgment of the Commission may be necessary to guard adequately against such unlawful uses of the waters of the state as are set forth in Section 6. If the order is not acceptable to the user, he may request a hearing on the matter involved, following which the Commission's final order of determination in this connection shall be conclusive unless reviewed in accordance with the provisions of the administrative procedures of Act No. 197 of the Public Acts of 1952, as amended, being sections 24.101 to 24.110 of the Compiled Laws of 1948, or any amendment thereto, in the Circuit Court of the County of Ingham, or for the county in which the user resides, or for the county in which the use is contemplated, upon petition therefor, filed within fifteen days after service upon said user of the final order of determination."

Water treatment plant filter backwash discharges will be controlled under either Section 7 or Section 8 (B) of Act 245, P. A. 1929, as amended. A typical time schedule for correction of an existing problem under Section 7 would call for construction plans within eight months from the date of the adoption of the Final Order, contract awards and construction start within fourteen months, and construction completion and abatement within twenty-four months. Solids removal will be required as a minimum unless it can be demonstrated that a lesser degree of treatment or control will provide for water quality enhancement commensurate with proposed present and future water uses.

The criteria and plan of implementation are consistent with the recommendations of all Federal enforcement conferences to which the State has been a party.

The Commission has as an objective the following:

"Waters in which the existing quality is better than the established standards on the date when such standards become effective will not be lowered in quality by action of the Water Resources Commission unless and until it has been affirmatively demonstrated to the Michigan Water Resources Commission and the Department of the Interior that the change in quality will not become injurious to the public health, safety, or welfare, or become injurious to domestic, commercial, industrial, agricultural, recreational or other uses which are being made of such waters, or become injurious to the value or utility of riparian lands; or become injurious to livestock, wild animals, birds, fish, aquatic life or plants, or the growth or propagation thereof be prevented or injuriously affected; or whereby the value of fish and game may be destroyed or impaired, and that such lowering in quality will not be unreasonable and against public interest in view of the existing conditions in any interstate waters of Michigan.

"Water which does not meet the standards will be improved to meet the standards."

APPENDIX C

WATERCRAFT POLLUTION CONTROL ACT

DEPARTMENT OF CONSERVATION

WATER RESOURCES COMMISSION

POLLUTION FROM WATERCRAFT

Filed with the Secretary of State.

(By authority conferred on the Water Resources Commission by Sections 2 and 5 of Act No. 245 of the Public Acts of 1929, as amended, being Sections 323.2 and 323.5 of the Compiled Laws of 1948.)

R 323.501. Definitions.

Rule 501. (1) "Act" means Act No. 245 of the Public Acts of 1929, as amended, being Sections 323.1 to 323.12a of the Compiled Laws of 1948, and the act which these rules implement.

(2) "Commission" means the Water Resources Commission of the Department of Conservation.

(3) "Litter" means bottles, glass, crockery, cans, scrap metal, junk, paper, plastic, garbage, rubbish or similar refuse discarded as no longer useful or usable.

(4) "Marine toilet" means a toilet on or in a watercraft.

(5) "Nonpollutional" means incapable of causing unlawful pollution as defined in Section 6 of the act, as amended.

(6) "Sewage" means human body wastes, treated or untreated.

(7) "Watercraft" means a contrivance used or capable of being used for navigation upon water whether or not capable of self-propulsion, except a passenger or cargo-carrying vessel including those subject to the Interstate Quarantine Regulations of the United States Public Health Service adopted pursuant to Sections 241, 243, 252 and 262 to 272 of Title 42 of the United States Code.

R 323.502. Sewage; use of pollution control devices and disposal facilities.

Rule 502. (1) No person shall operate a marine toilet on a watercraft on the waters of this state so as to discharge sewage into such waters unless the sewage has been rendered nonpollutional by passage through a device approved by the Commission.

(2) No person owning or operating a watercraft having a marine toilet shall use or permit the use of such toilet on the waters of this state unless the toilet is equipped with one of the following pollution control devices:

(a) A holding tank which will retain all sewage produced on the watercraft.

(b) An incinerating device which will reduce to ash all sewage produced on the watercraft.

(c) A device determined by the Commission to be capable of rendering the sewage discharges nonpollutional in accordance with the requirements of the act.

(3) No person shall dispose of sewage accumulated in a holding tank or any other container on a watercraft in such manner that the sewage reaches or may reach the waters of this state except through a sewage disposal facility approved by the State Department of Public Health or its designated representative.

R 323.503. Watercraft registration; marine toilet information.

Rule 503. An applicant for a certificate of number for a watercraft pursuant to Section 33 of Act No. 303 of the Public Acts of 1967, being Section 281.1033 of the Compiled Laws of 1948, shall disclose at such time to the Commission whether the watercraft has in or on it a marine toilet, and if so, whether the toilet is equipped with a pollution control device as required by these rules. The Commission may request the Secretary of State to provide it with the name of an applicant whose application indicates the absence of such pollution control device on a marine toilet.

R 323.504. Litter disposal.

Rule 504. Disposal of litter is subject to the provisions of Act No. 106 of the Public Acts of 1963, as amended, being Sections 752.901 to 752.906 of the

Compiled Laws of 1948.

R 323.509. Effective date.

Rule 509. These rules are effective January 1, 1970.

In addition to the information that we have shown in the way of performance statutes in Appendix A, under Berlin Township, the first one noted, under comments, the last sentence states that the Commission will review the problem at an early date.

At the May 1, 1968 Commission meeting the Water Resources Commission scheduled a hearing for this matter to be called at its June 26-27, 1968 Commission meeting.

Under the industries section, Ford Motor Company, Rouge Plant, it is noted that the company has requested an extension of time to October 1 of 1969 to provide additional oil control facilities for its Gate 11 sewer, or Gate 11 discharges.

At the May 28-29, 1968 Commission meeting this extension of time was granted. The time was necessary so that these facilities can be constructed on land that will be made available as a part of the Rouge River flood control project.

Now, in the interim period, in the way of providing some additional protection, the Ford Motor

Company has on order and it is scheduled for delivery in July an oil recovery device identical to the one described by the American Oil Company at the Lake Michigan Enforcement Conference in Chicago, and this unit will be placed in operation on the Rouge River to recover oil that may escape from the treatment facilities that have now been provided, and will provide additional protection during this interim period.

Now, under the Monsanto Company, the Trenton Plant, we have noted that plans have been approved, and construction has been completed, and facilities are in operation.

I wish to call your attention to the scheduled construction date, that was November 1, 1969. The facilities have been placed in operation some eighteen months ahead of schedule. This is a phosphate removal, and if we would look at this in terms of equivalent population from the standpoint of phosphate, this provides treatment for the phosphate equivalent of about one million people, and this is in operation today.

Under the Wyandotte Chemicals Corporation, the North Works, Wyandotte; South Works, Wyandotte, we have noted that the conference was scheduled for the May 28-29, 1968, Commission meeting, to consider a request for an extension of time to meet the solids requirement for three of its gate outlets.

The Commission considered this matter at its meeting, as noted, and the extension was granted for the three outlets until January 1 of 1969.

Now, under the Interstate Standards and the program to control and abate pollution, there is only one paragraph that I would like to call attention to, and this is with respect to phosphate removal. In the final implementation on the Interstate Standards, the Commission has stated it is the Commission's intent to require that nutrients in public waters, particularly with respect to phosphates traceable to industrial or municipal waste sources be controlled. Persons proposing to make a new or increased use of waters over the state for waste disposal purposes will be required to utilize such technology and processes which are known. The long-term objective is to require that phosphates traceable to all industrial and municipal waste sources be controlled on or before June 1, 1977.

Now, in addition to this report, I would like to mention three pieces of legislation that have been passed by the Michigan legislature in its present session. We have had a state grant program for two years. This has operated to extend the same sort of program provided by the Federal act; that is, when we have utilized all of our Federal funds, thirty per cent state grants would be made to municipalities.

This act has now been amended so that the state will join in on a twenty-five per cent share of the cost of the project, and fifty per cent, then, would be the federal grant, and local government would make up the other twenty-five per cent. We now have the authorizing legislation to participate in that program.

The legislature also passed an act which will place before the people of the State of Michigan the question of a bond issue of $335,000,000 to finance the state's twenty-five per cent share, and to refinance some of the fifty per cent Federal share, and hopefully during the period of construction, the Federal Government will authorize the appropriation or will appropriate money that has now been authorized in the Commission act.

The third and last piece of legislation that I wish to mention now: first, the operation of facilities that serve the public has been by a certified operator, as required by statute, and mandatory reporting of the effluent characteristics has been in effect for quite some time.

New legislation has been passed which requires the operation of industrial wastewater treatment facilities by an operator certified by the Water Resources Commission as to his competency. It also requires that the industrial waste discharger must file monthly reports with the Water Resources Commission which will show the quantity and quality of the liquid wastes discharged into any public lake or stream.

Mr. Chairman, that completes my prepared remarks.

CHAIRMAN STEIN: Thank you for a real excellent report.

Before I throw this open for questions, I would like to have, if I may, page five of this gray book, where we talk about watercraft pollution control. That is about the same requirement that we had in Lake Michigan. I know Indiana agreed with this on Lake Michigan.

Indiana, is this your policy on Lake Erie, too, or not?

MR. POOLE: Well, Mr. Chairman, the Indiana law now outlaws the discharge of wastes from boats on Indiana waters except Lake Michigan, so I think we could say that the Indiana policy as far as Lake Erie watershed is currently there can be no discharge.

CHAIRMAN STEIN: No discharge.

What this rule says, then, in all watercraft not subject to Federal control, that a marine toilet has to be provided with a holding tank, sewage incinerator or device which has been determined by the Commission -- that is the Michigan Commission -- to be capable of rendering sewage discharges -- et cetera. I understand you haven't certified them as yet.

MR. OEMING: We are not about to certify anything but a holding tank or incineration device.

CHAIRMAN STEIN: Right.

Now -- and I am asking just for clarification -- how do the other States on Lake Erie feel about that kind of restriction?

MR. LYON: Well, I would say that philosophically that is a very good requirement. Frankly, we in Pennsylvania have not adopted any regulations because we are being pulled apart by a number of diverse interests. We finally feel that this is an area under which the Federal Government should move because boats that are immobile are going to create a lot of problems by having different requirements. But from a purely technical standpoint, the recommendation of the regulation that Indiana has -- Michigan has adopted, which is apparently quite similar to that of the Department of Ontario, is a good one, and we would agree with that and we hope that everyone would go along and we can close the gap and adopt it ourselves.

CHAIRMAN STEIN: Well, you know you are using -- we can't always use that technique. Before I poll the rest of them, you say this is an area which the Federal

Government should approve. What we are trying to do in Lake Michigan and Lake Erie, if we can, is get a group of States to agree to something. If we get enough States waiting back to close the gap, we are never going to close it. We have gotten uniformity in the four Lake Michigan States.

Now, my reason for going through this is to try to see if we are even within striking distance of trying to get uniformity among the five States on Lake Erie. If we are, I think we are going to be a lot closer to a national policy on the small boat control.

Mr. Metzler, how do you feel about this?

MR. METZLER: Well, New York has a law which requires that we have all of the boats licensed by, I believe it is, next April 1, and we are in the process of final determination by the Conservation Department, which is the agency that will enforce it. We make the recommendation.

I think your concept here is a good one. I am not prepared to say, at this moment -- because it is a two-agency operation -- what we will finally come up with.

CHAIRMAN STEIN: It seems to me, again, the basic issue is whether we are going to get a massive chlorinator or a holding tank. That doesn't say that the legislation, as developed by Michigan, doesn't have a theoretical escape hatch -- a device which has been determined by the Commission to be capable of rendering the sewage discharges nonpollutional. I guess the notion is that someone might come up with that in the future.

As I understood the four States bordering Lake Michigan, while these were very interesting devices, they hadn't found any at the present stage which was nonpollutional as far as the effects on Lake Michigan were concerned and the effect of the operation was complete unanimity on the holding tank theory.

MR. OEMING: That is correct.

CHAIRMAN STEIN: Now, Mr. Eagle, may we have your views on that?

MR. EAGLE: Well, I am not prepared or authorized to speak for the State of Ohio on this officially. I think that some type of a holding tank, personally, would be in order, particularly on new craft. I think it would be difficult to enforce it for existing craft. I don't know whether Michigan expects to do that.

CHAIRMAN STEIN: Yes, all four States.

MR. EAGLE: I would like to counter with a question to you, Mr. Stein. What are you going to do about large vessels? What is the Federal Government going to do about the large vessels, particularly international, and so on?

CHAIRMAN STEIN: This has come up before. I just don't know. I stated this before. The point is this isn't a very easy problem to handle, and I saw Mr. Butrico, who worked for me for years in the Public Health Service -- I remember twenty years ago we used to work on vessel sanitation. The problem here is even if you put controls on all U.S. vessels, what do you do with the foreign flag vessels coming in? The question that always gets raised -- and the validity of this, you can judge for yourself -- is: the effect of putting a stringent sanitary regulation on U.S. vessels just means the flight of those vessels to a foreign flag and a foreign registry, and their being in the same place -- and the question is: what have you accomplished? This is, I think, a very, very difficult operation.

Now, the Congress and the Federal authorities are struggling with this. I don't know if this can be arranged by any less than a treaty operation, and you know how long that would take to go into effect.

It is clear to me that, at the present time, we are not in a position to come up with an agreement as we had on Lake Michigan.

But one of the questions that we might have on this is whether it would be worthwhile for the States to get together with us -- and they did have a little technical committee in Lake Michigan before we developed this -- and see if the States will come up with uniform requirements or this would be worthwhile.

I just wanted to do that because you raised a very interesting point.

MR. PURDY: That time wasn't charged to my ten minutes, was it?

CHAIRMAN STEIN: No, sir. No, you did well within the ten minutes.

Are there any other comments or statements on the Michigan report?

Well, again -- and let me try to summarize -- I think we are doing very well for the three States -- having heard from Pennsylvania and Indiana and Michigan so far, who have made their presentations. I think the programs are moving apace.

Now, of course, there is one problem that we are obviously going to have to face up to, and that is the phosphate problem. I think we have a good example with one of our major chemical companies showing how they can remove phosphates. I guess they are in business, aren't they?

MR. PURDY: I should point out, Mr. Stein, that for those that discharge directly into Lake Erie or the Detroit River that our time schedules include phosphate removal within the time schedules that we are talking about, and that includes an 80 per cent removal.

CHAIRMAN STEIN: I think that should be noted, and I don't know that -- I think Michigan is probably in the forefront in this in the States, and I know they have been scrupulous about this in their stipulations and orders.

Are there any other comments or questions? If not, thank you very much.

If the conferees will do this -- bear with me on this, because of schedules -- I am beginning to see the daylight and I think we might get through today. But before we recess possibly this afternoon, I wonder if we could hear from Mayor Locher of Cleveland, the former Mayor of Cleveland.

Mayor Locher, would you come up?

MR. LOCHER: Thank you very much, Mr. Stein, and members of this conference for an opportunity to speak very briefly.

I have already appeared on behalf of the Izaak Walton League in Columbus on two occasions with regard to this question of drilling in the lake, and likewise have testified with regard to the Cuyahoga River only last week at the hearings that were held here in Cleveland, Ohio, on the standards, and, therefore, I would ask your permission, Mr. Chairman, to introduce those three statements in the record, in the interest of saving time, if I may, and then to speak briefly --

CHAIRMAN STEIN: Yes.

MR. LOCHER: -- to speak briefly on the subject of drilling in the lake, which I believe is much more serious than has been indicated. I don't believe -- if I may respectfully disagree with you, Mr. Chairman -- that it is only a peripheral or small problem. But I believe that a catastrophe could very likely occur and if it does, it would indeed be very serious, because I am told there is no way to remove oil from the water supply that has yet been developed, and for that reason it goes to the very heart of the potability of the water itself for the inhabitants of those in the Lake Erie watershed.

Furthermore, a few years ago, in the vicinity of Hinckley, Ohio, an oil well did break loose. It was a gusher. It did flow for many, many days and it did a great deal of damage..

From knowledge which the Izaak Walton League has been able to acquire, wherever there has been drilling there has been a concomitant problem. I refer to Maracaibo, Venezuela, where a large section of a very large lake indeed was so covered with crude oil that it posed a fire problem. I refer to Beirut, Lebanon, where a break in an oil line damaged entire beaches and caused a very severe problem there costing millions of dollars to the American oil interests to restore.

I refer to Cook's Inlet in Alaska, the Gulf of Mexico, the offshore drilling in California and indeed I don't know of any place in the entire world where there has been drilling in lakes or in rivers that we have not had the problem, including some problems on the northern shore of Lake Erie itself.

If Pennsylvania is going to experiment with the safety of all of us, it poses this interesting situation: If they strike it rich, they win; but if there should be a catastrophe and if there should be a well break loose; and if there should be a large portion of Lake Erie covered with oil. I am afraid they would say, "Too bad, fellows, you lose." And that is exactly the situation that could happen if we were to allow this to go forward.

We had an expert testify, Mr. Chairman, in Columbus, Ohio, and as a result of those hearings the State of Ohio did defer drilling, and Mr. Lee Birch, who was an expert in the field, stated that no matter how strongly you draw up these regulations, there are no known controls to prevent an oil well from becoming a gusher and breaking loose. If there were, I am sure that the Federal Government would have insisted that those wells in the Gulf of Mexico, over which it has control, and in Alaska, and everywhere else, would have been so equipped. But there is no known technique, and for that reason, we have had those terrible problems in every place that I have listed.

Furthermore, there is no way to prevent a piece of heavy debris or a boat itself from sinking to the bottom of the lake, and you are not going to have this oil and gas come from the well on the surface of the water -- that is a cinch. It will have to come through some kind of a conveyance, a pipeline, and if some boat -- even a small yacht -- were to sink and damage such a pipeline, you would have an awfully difficult time, and perhaps it would take weeks to discover just where that break was. In the meantime, there goes your water supply.

Then, again, after the fact, I am sure we would levy some rather strong and harsh penalties upon the speculator who was drilling for oil and gas in Lake Erie, but the damage will have been done.

Let's not gamble the water supply of millions of people for a few hundred thousand dollars of royalty. I suggest, therefore, that this conference go on record and simplify this matter, and say that "we shall not permit drilling in Lake Erie or anywhere in the Great Lakes so that we would have the pollution or situation where one State only is going forward in a highly speculative and dangerous enterprise."

Then, with regard to dredged materials, it was stated that those dredged materials, Mr. Chairman, are not bad -- they are only half bad because half of it is a matter of water that comes out.

Let me read from the book which I commend to all of you. I have no interest in the royalty from the book, but it was written by William Donohou Ellis, and he spoke of the Cuyahoga River: "The red of the water is created by iron, mud, sulphur, crude oil and pickle liquor from the mills, and for one hundred years, those who have known which side midwest bread is buttered on have thanked God, also Sam Mather, John D. Rockefeller," et cetera -- and then it goes on: "Sometimes the old river seems to be a combination of one-third mud from the still rural headwaters, one-third sludge and one-third pickle liquor from the great mills, but it continues making history."

Then he points out how important this tiny but mighty river actually is.

Now, one further thought: The Waltonian philosphy, I believe, should be kept uppermost by this conference. And that is best stated by a judge recently who heard a case in Illinois, and this had to do with the spillage of oil, and it was a relatively small spillage, as those things go. But the judge went on to say that, "I agree," he says, "with Mr. Hersod, attorney for the plaintiff, when he quoted the unnamed judge that there is no such thing as a little pollution. I conclude, as a matter of law, that the oil slick in question was a pollution of waters, as alleged in the complaint." And then he said, "I come to the conclusion, as a matter of law, that it doesn't make any difference. The cases hold that in instances of this kind, the intent is not necessary."

And so, I urge upon this conference to take a strict view with regard to this highly dangerous and risky business of allowing a few speculators to gamble with our precious water supply. I urge also that we watch history, that we learn from history, which has shown that in the Gulf, off the coast of California, at Cook's Inlet, right here a few miles from Cleveland, Ohio, where a well has broken loose, at Maracaibo, at Beirut, all these instances would seem to argue, I believe, that in the interest of safety, let's put the public interest first and foremost.

Thank you.

(Statement by Ralph S. Locher on behalf of the Izaak Walton League and his own behalf before Wayne Conner, Chief, Division of Oil and Gas, Columbus, Ohio, February 5, 1968, follows:)

Objection to the Hearing on Rules and Regulations

Objection is hereby made to the consideration of rules and regulations for drilling in Lake Erie. The public has had absolutely no opportunity to be heard on the merits of oil and gas drilling in Lake Erie. Therefore, the rules and regulations will be drafted and the whole matter will be all wrapped up in a neat little package without the public ever having had its say.

The proposed rules and regulations have a special significance, in that Section 1505.99, Revised Code, provides a penalty consisting of a fine of "not less than $100 nor more than $500." What a weak reed that is!

Water - Our Most Vital Natural Resource

Water is paramount as a natural resource. The area in and about Cleveland, Ohio, contains four major water intakes serving 2,000,000 people in all of Cuyahoga County and three adjacent counties: Lake, Summit and Medina Counties. The water supply and fire protection afforded by the Water Division cannot be endangered. Indeed, we of this generation are charged with the duty of holding this vital natural resource of fresh water in trust for posterity.

Water is paramount as a natural resource and is the backbone of Ohio wealth, available in unlimited quantity from Lake Erie and the Ohio River. We cannot and should not jeopardize its quality. Furthermore, national and state water quality objectives are to reduce pollution at all levels. The United States Public Health Service is presently engaged in evaluating water standards and the Great Lakes and international agencies are working toward insuring the potable character of the waters of Lake Erie.

It should be remembered that the four Cleveland water intakes are located to produce the best quality water possible and these raw water intakes cannot be shut down or be contaminated since they are in constant use.

Gusher Could Ruin Water Supply

Should an uncontrolled oil well, such as the one which came in near Lodi, Ohio, several years ago, pollute Lake Erie, the water supply of some 2,000,000 people would be literally destroyed over-night. This statement is based upon the firm opinion of City of Cleveland engineers who advised that oil and its various components cannot be removed from the water supply through the presently known filtration methods and procedures.

Beach Areas Endangered

Further, the Cleveland Regional Planning Commission points out in a recent report that 119 acres of beaches are needed in this area, but that only fifteen per cent of the shoreline is available for public recreation. The proposed oil and gas drilling sites would jeopardize the shoreline of Lake Erie, including those areas not subject to population concentration and adjacent to public land use for recreation.

Royalties Insignificant

It has been estimated that the royalty reverting to the State of Ohio by leasing land under the lake would approximate $200,000 a year. We should not hazard the prime resource of the State of Ohio for any sum. However, the $200,000 which might accrue would never compensate for the threatened capitalized loss to the citizens and other beneficiaries of the waters of Lake Erie.

Water-Borne Commerce Impeded

The City of Cleveland has made real progress toward becoming a world port and the future promises greater gain when the harbor depth is increased to twenty-seven feet, allowing even larger freighters to reach our docks. Furthermore, people are finding more pleasure in small watercrafts and water recreation, taxing our small craft harbor development to the limit. While precautions are attempted to be written into the proposed leases, there still exists hazard to small crafts which come from the very nature of drilling operations. The drilling operations and the production methods will serve as a hazard to the shipping vessels as well, generally. The drilling rigs and the distribution facilities in and of themselves would be a navigational hazard to large cargo vessels as well as smaller pleasure crafts.

To be sure, the presently proposed leases entail development off the shore in Ashtabula County. It should be pointed out that when the lake is frozen and when the northeast winds prevail, which conditions occur over a considerable portion of the year, the lake currents are not clearly defined and our Nottingham Road intake is in close proximity to Ashtabula County.

Conclusion

For reasons given above, it is my firm conviction that it would be a mistake to permit off-shore drilling for gas and oil in Lake Erie. In fact, it would be a horrendous disservice to our state and nation, the fish and water fowl life, and, above all, the people who live in the Lake Erie Basin, tributary to this natural resource.

At this point, I should like to read into the record a resolution adopted by the Ohio Division of the Izaak Walton League of America at its 43rd Convention, held in Cleveland, Ohio, on October 9, 1965.

Projected Oil Drilling Operation in Off-Shore Waters of Lake Erie Pose Threat to Source of Supply of Fresh Water to Millions of Users

Whereas, the State of Ohio has a projected program of drilling for oil in off-shore areas of Ohio's Lake Erie waters, through lease arrangements with private industry; and

Whereas, millions of citizens are dependent upon this source for their life-sustaining supply of fresh water; and

Whereas, the occasion of an uncontrolled oil well could jeopardize this water source for undetermined lengths of time; and

Whereas, even with the exercise of great care in the conduct of drilling operations, where can be no assurance that such a catastrophic calamity couldnot occur; and

Whereas, in the event that Lake Erie's waters should become contaminated with oil, that oil and its various components cannot be removed from the water supply through presently known methods and procedures; and

Whereas, a report of the Cleveland Regional

Planning Commission indicates that 119 acres of beaches are needed in the Cleveland area alone; while less than fifteen per cent of Lake Erie's shoreline is available for public recreation. Projected oil drilling in Lake Erie would jeopardize its shoreline, including areas not subject to population concentration and adjacent to public recreational land; and

Whereas, drilling operations, drilling rigs, and the distribution facilities in and of themselves would constitute navigational hazards to large cargo vessels as well as to smaller pleasure crafts; and

Whereas, it has been estimated that the royalty reverting to the State of Ohio by leasing land for drilling sites under the lake would approximate $200,000 a year; and

Whereas, we believe that we should not hazard this prime resource of the State of Ohio for any sum; as any anticipated royalties from this source could never compensate for the threatened capitalized loss to the beneficiaries of the bounties which Lake Erie so generously bestows:

Now, therefore, be it resolved, by the Ohio Division of the Izaak Walton League of America in convention assembled this ninth day of October, 1965, at Cleveland, Ohio, that it is our firm belief that it would be a most grievous mistake to permit off-shore drilling for gas and oil in Lake Erie.

Be it further resolved that copies of this resolution be forwarded to the following:

Murray Stein, Chief Enforcement Officer, of the U.S. Public Health Service of the Department of Health, Education and Welfare, Washington, D.C.

Fred Morr, Director, Ohio Department of Natural Resources, Columbus, Ohio.

Dr. Emmett Arnold, Chairman, Ohio Water Pollution Control Board, Columbus, Ohio.

Mayor Ralph S. Locher, City Hall, Cleveland, Ohio.

Mrs. James H. Angel, Chairman, Citizens for Land and Water Use, 2084 Elbur Avenue, Lakewood, Ohio 44107.

Mrs. Esther Smercina, Chairman, South Shore Subcommittee on Lake Erie Basin Study of the League of Women Voters, 2074 Alton Road, Cleveland, Ohio 44112.

Above resolution prepared and submitted upon instructions from the Board of Directors of Western Reserve Chapter, I.W.L.A., at a meeting held on September 22, 1965.

Very respectfully submitted, Seba H. Estill, Committee Chairman, 3577 Cummings Road, Cleveland, Ohio

44118.

Remarks

Water, our most important natural resource, is reaching new heights of importance day by day. Ancient civilizations and flourishing cities are known to have perished because their supply of water became exhausted. In our own generation, water is being literally fought for in individual and governmental bodies. The great need for large supplies of water by industry makes it advisable for one area to grow and prosper, whereas others have already reached their maximum potential.

The above thoughts were forceably brought to mind only within the past summer by two events: First, the Chicago Sanitary District Water Diversion Bill in the Congress of the United States was vigorously opposed by most of the cities in the Great Lakes Basin, including Cleveland. Mayor Celebreeze, Port Director Rogers, and I appeared in opposition to the proposed diversion of 1500 cubic feet per second urged upon the Congress by Chicago and the Illinois Congressmen. We pointed out many other arguments that water should never be diverted from one watershed to another. To do so would violate one of the cardinal principles of the common law and of American law on the subject of water and riparian rights.

Secondly, and by way of further illustration, the State of Ohio is now preparing specifications to permit off-shore drilling for oil and gas in Lake Erie. The City of Cleveland is faced with the prospect of drilling operations in its own front yard, so to speak. It is proposed to advertise for bids to allow for drilling in 13,655 acres immediately north of the Cleveland harbor and the City of Lakewood and part of Rocky River, beginning one-half mile from shore and extending outwardly. This area includes two city water intakes and terminals. These facilities constitute the sole present source of supply for the west side of our city.

I call this matter to your attention because of the various implications it raises. For one thing, the expected oil and gas producing strata or sand only recently produced an oil gusher south of Cleveland, near Lodi, Ohio. Should an uncontrolled oil well pollute Lake Erie, the Cleveland water supply would be literally destroyed overnight. I say this because the City of Cleveland water engineers advise that oil and its various components cannot be removed from the water supply through the presently known filtration methods and procedures. A letter I just received recently from the officials of Long Beach, California, carries the information that off-shore drilling "has caused a critical subsidence condition in our harbor, one section of our inner harbor having settled 25 feet ...."

Consequently, when the proposed specifications are made known, public officials as well as those of you connected with the water supply industry, must make certain that all precautions are taken to avoid possible damage to intake tunnels by drilling and dynamiting; that danger of drilling and well rigs to freighters and pleasure craft be considered; that interference of gas and oil exploration and deepening of the channel for deep-draft ships, which will come in greater numbers with completion of the St. Lawrence Seaway, will be taken into account and that destruction of fish life by dynamiting must not be permitted.

(The following article appeared in The Cleveland Press, on Saturday, February 3, 1968:)

"More Danger for Lake

"Lake Erie already has the hapless reputation of a 'dead sea,' thanks to the pollution that has ruined its waters.

"Now it is in danger of growing even more polluted through oil drilling. Ohio, New York and Pennsylvania plan to lease submerged Lake Erie lands for oil purposes.

"George Harlow, head of the Lake Erie office of the Federal Water Pollution Control Administration, categorically says there is a pollution threat from the drilling which would take place two to three miles from the shoreline of Ashtabula County.

"Pollution from drilling can come from three sources: the oil itself, brine and the lubricating oil from the underwater machinery.

"On Monday the state will hold hearings in Columbus to discuss the rules for Lake Erie drilling, particularly as it affects shipping and pollution. The oil drillers should be made to prove their case, which may be difficult.

"Certain questions should be asked the proponents of Lake Erie drilling:

"Is the oil which may be obtained absolutely necessary to our economy?

"Will it mean cheaper gasoline to Ohio motorists?

"How will drilling be terminated if pollution occurs?

"Who will pay to clean it up?

"Officials should be wary of such statements as this from a New York official: 'The risk of any of our operations pulluting are negligible.'

"Are the risks of a broken oil line negligible? Should such an accident occur, the mess could be as disastrous as the tons of spilled oil that washed the Cornwall coast of England last year.

"And once state officials let the drilling commence, even with tight safeguards rigidly enforced, pollution seems inevitable. This has been part of the tragic history of industrial wastes in Lake Erie.

"It is hard to conceive of any situation which would justify drilling for oil in Lake Erie."

(The following article appeared in The Plain Dealer on February 7, 1968:)

"Hold Off on Lake Oil Drilling

"There is no compelling reason why the oil and gas reserves which lie under Lake Erie should be tapped immediately.

"There is a compelling reason to preserve the lake water. And there is some danger that oil and gas drilling would add pollution to the lake at the very time when large-scale efforts are underway in Ohio and, indeed, throughout the Great Lakes area to reduce pollution and save the lakes from ruin.

"Therefore, Ohio -- along with Pennsylvania and New York, which also are considering leasing state-owned waters in the lake for oil and gas explorations -- should hold up until it can be proved that science has advanced to the point that pollution will not result.

"Experts testifying on drilling regulations proposed by the oil and gas division of the Ohio Department of Natural Resources expressed grave doubts that pollution could presently be avoided.

"Representative George V. Voinovich of Cleveland proposes calling a halt to proposed drilling until the Ohio House can make a thorough investigation of the pollution threat and until the public can evaluate the risks against the benefits that may be derived from exploiting the oil and gas reserves.

"It is a sensible proposal and has won the support of the resources department, whose chief concern, after all, is protecting the state's natural resources.

"Although drilling has been authorized by the legislature, the department has the power to hold it off by delaying promulgation of regulations. It would be wise to do so until pollution-free operations can be assured."

(Statement of Ralph S. Locher on behalf of the Izaak Walton League and in his own behalf before a Sub-committee of the Natural Resources Committee, chaired by the Honorable Morris Boyd, Wednesday, February 21, 1968:)

I appreciate this opportunity to share with your honorable body some of the views of the Izaak

Walton League and of my own concerning the proposed drilling for gas and oil in Lake Erie. To my knowledge, there has been no public hearing proposed by the State of Ohio affording an opportunity to the public to be heard relative to drilling in Lake Erie.

Section 1505.08 of the Revised Code provides that "... the Chief of the Division of Geological Survey, with the approval of the Director of Natural Resources, the Attorney General, and the Governor, may issue permits and make leases to parties making application for permission to take and remove sand, gravel, stone, gas, and other minerals from and under the bed of Lake Erie...."

On February 5, 1968, a hearing was had before Wayne Conner, Chief, Division of Oil and Gas, to "consider the adoption of rules and regulations relating to the issuance of permits for the drilling of wells in strata beneath the waters of Lake Erie and the operation thereof." The rules, according to the Notice of Hearing, "will establish procedures that will promote the maximum ultimate recovery of oil and gas from reservoirs beneath Lake Erie by application of accepted practices of conservation...." I have quoted from the Revised Code of the State of Ohio and the Notice of Hearing as a foundation for two points.

First, a hearing was had on proposed rules and regulations for drilling in Lake Erie even before the public could be heard on the merits of drilling. In my judgment, there was a disposition on the part of the Governor, the Attorney General, and the Director of Natural Resources, to proceed with the issuances of permits and granting of leases. According to the Cleveland Plain Dealer of last Sunday, the Director of Natural Resources has so indicated. Richard G. Zimmerman of the Plain Dealer Bureau, in his column "Credibility Gap on the Olentangy," stated, "late last year, Natural Resources Director, Fred E. Morr, joyously crowed that Ohio was leading other Great Lakes states in opening a portion of Lake Erie to private oil and gas interests."

Second, the proposed rules and regulations are designed to promote the maximum, ultimate recovery of oil and gas from Lake Erie. Were it not for this hearing and, hopefully, others, the public interest could not have been asserted in an official manner. Particularly is your hearing important, since the Revised Code of the State of Ohio, Section 1505.99, is a weak reed, for it provides a penalty as follows:

"1505.99 Revised Code, penalty

"(a) Whoever violates Section 1505.07 of the Revised Code, shall be fined not less than one hundred dollars nor more than five hundred dollars."

Hon. Ralph Locher

Water - Our Most Vital Natural Resource

Water is paramount as a natural resource. The area in and about Cleveland, Ohio, contains four major water intakes serving 2,000,000 people in all of Cuyahoga County and three adjacent counties: Lake, Summit and Medina Counties. The approximate valuation of the City of Cleveland water facilities is $100,000,000. The water supply and fire protection afforded by the Water Division cannot be endangered. Indeed, we of this generation are charged with the duty of holding this vital natural resource of fresh water in trust for posterity.

Water is paramount as a natural resource and is the backbone of Ohio wealth, available in unlimited quantity from Lake Erie and the Ohio River. We cannot and should not jeopardize its quality. Furthermore, national and state water quality objectives are to reduce pollution at all levels. The United States Public Health Service is presently engaged in evaluating water standards and the Great Lakes and international agencies are working toward insuring the potable character of the waters of Lake Erie.

It should be remembered that the four Cleveland water intakes are located to produce the best quality water possible and these raw water intakes cannot be shut down or be contaminated since they are in constant use.

Gusher Could Ruin Water Supply

Should an uncontrolled oil well, such as the one which came in near Lodi, Ohio, several years ago, pollute Lake Erie, the water supply of some 2,000,000 people would be literally destroyed over-night. This statement is based upon the firm opinion of City of Cleveland engineers who advised that oil and its various components cannot be removed from the water supply through the presently known filtration methods and procedures.

Other areas of the world which have permitted underwater drilling and have experienced terrible loss are Lake Maracaibo, Venezuela, and more recently the Gulf of Mexico. Captain Charles Sebastian of Grand Isle, Louisiana, recently was quoted in the magazine "Industrial Research, Inc."

"'About 2,000 oil-drilling rigs now are operating off the coast of Louisiana,' stated Captain Charles Sebastian, a charter boat skipper from Grand Isle, Lousiana, 'and every one of these rigs is releasing oil into the Gulf of Mexico.'

"That assertion was made at the twelfth annual International Game Fish Conference, San Juan, Puerto Rico, in late November. Several dozen aerial photographs of oil-drilling platforms were shown to the conferees; and in each picture an oil slick was evident around the platform.

"According to Sebastian, each drilling rig uses a mixture of oil and mud to hold down any gas pressure that may exist in the hole -- and this pressure may be as great as 3,000 psi. 'The pumpings that come up inside the well go through a shaker, or separator, and drop into the water. The lubricating medium is diesel oil -- approximately 1,500 gallons in each hole.'

"Production platforms also discharge oil into the water. Sebastian claims, "Tanks are used to separate the oil from water, because nearly all wells produce some water,' he said. 'After separation, the water goes overboard and carries a great deal of oil with it. Each well pollutes the water to some extent, and as many as sixty-four oil wells may be worked from one platform!'

"Sebastian further charged that, in early November, one company lost over five million gallons of oil as a result of a ruptured pipeline on the Gulf floor. 'In my boat,' he said, 'I ran through 45 miles of crude oil -- just as thick as you can put crude oil on the surface. For several days it got worse. I reported the matter to the man in charge of production at one of the companies and he denied that his company had a leaking pipeline. He was sincere. He simply did not know about the leak.

"'A week later the company discovered the break in the pipeline. They had lost about $300,000 worth of oil into the Gulf before they found out they had a leak!'

"Sebastian's presentation was one of twelve papers concerning problems of game fishing, marine research, conservation, and pollution given at the meeting held November 17-18. Other papers on aquatic pollution were given by Dr. J. Frances Allen, Chief, Water Quality Requirements Branch, Federal Water Pollution Control Administration; by Dr. Frederick Kalber, Florida Atlantic University; and by Mrs. Anne H. Bosworty, Carmel, California, a member of the International Women's Fishing Association.

"The role and functions of the marine council and marine commission were outlined by Dr. John Gottschalk, Director, Bureau of Sport Fisheries and Wildlife; future developments in sport fisheries were discussed by Henry Lyman, Publisher, 'The Salt Water Sporsman' magazine; while the spawning and migrations of game fishes were explained by Donald S. Erdman, Fish and Wildlife Division, Department of Agriculture, Puerto Rico, and by Frank J. Mather, III, Research Associate, Woods Hole Oceanographic Institution.

"Joseph W. Penfold, Conservation Director, Isaak Walton League of America, dealt with the subject of fish conservation and public responsibility; Bori Olla, Sandy Hook Marine Laboratory, discussed rhythms of activity in bluefish; and William M. Stephens, Managing Editor, 'Oceanology International,' gave a presentation on research submarines.

"Following the sessions, some of the delegates visited marine research facilities in the Virgin Islands and dived on some of the coral reefs.

"The International Game Fish Conference, sponsored by the International Oceanographic Foundation was held in cooperation with the Gulf and Caribbean Fisheries Institute."

Proposed Oil Drilling Operation in Off-Shore Waters of Lake Erie Pose Threat to Source of Supply of Fresh Water to Millions of Users

Whereas, the State of Ohio has a projected program of drilling for oil in off-shore areas of Ohio's Lake Erie waters, through lease arrangements with private industry; and

Whereas, millions of citizens are dependent upon this source for their life-sustaining supply of fresh water; and

Whereas, the occasion of an uncontrolled oil well, could jeopardize this water source for undetermined lengths of time; and

Whereas, even with the exercise of great care in the conduct of drilling operations, there can be no assurance that such a catastrophic calamity could not occur; and

Whereas, in the event that Lake Erie's waters should become contaminated with oil, that oil and its various components cannot be removed from the water supply through presently known methods and procedures; and

Whereas, a report of the Cleveland Regional Planning Commission indicates that 119 acres of beaches are needed in the Cleveland area alone; while less than fifteen per cent of Lake Erie's shoreline is available for public recreation. Projected oil drilling in Lake Erie would jeopardize its shoreline, including areas not subject to population concentration and adjacent to public recreational land; and

Whereas, drilling operations, drilling rigs, and the distribution facilities in and of themselves would constitute navigational hazards to large cargo vessels as well as to smaller pleasure crafts; and

Whereas, it has been estimated that the royalty reverting to the State of Ohio by leasing land for drilling sites under the lake would approximate $200,000 a year; and

Hon. Ralph Locher

Whereas, we believe that we should not hazard this prime resource of the State of Ohio for any sum; as any anticipated royalties from this source could never compensate for the threatened capitalized loss to the beneficiaries of the bounties which Lake Erie so generously bestows;

Now, therefore, be it resolved, by the Ohio Division of the Izaak Walton League of America in convention assembled this ninth day of October, 1965, at Cleveland, Ohio, that it is our firm belief that it would be a most grievous mistake to permit off-shore drilling for gas and oil in Lake Erie.

Be it further resolved, that copies of this resolution be forwarded to the following:

Murray Stein, Chief Enforcement Officer, of the U.S. Public Health Service of the Department of Health, Education and Welfare, Washington, D.C.

Fred Morr, Director, Ohio Department of Natural Resources, Columbus, Ohio.

Dr. Emmett Arnold, Chairman, Ohio Water Pollution Control Board, Columbus, Ohio.

Mayor Ralph S. Locher, City Hall, Cleveland, Ohio.

Mrs. James H. Angel, Chairman, Citizens for Land and Water Use, 2084 Elbur Avenue, Lakewood, Ohio 44107.

Mrs. Esther Smercina, Chairman, South Shore Sub-committee on Lake Erie Basin Study of the League of Women Voters, 2074 Alton Road, Cleveland, Ohio 44112.

Above resolution prepared and submitted upon instructions from the Board of Directors of Western Reserve Chapter, I.W.L.A., at a meeting held on September 22, 1965.

Very respectfully submitted, Seba H. Estill, Committee Chairman, 3577 Cummings Road, Cleveland, Ohio, 44118.

(The following article appeared in The Plain Dealer on February 7, 1968:)

"Hold Off on Lake Oil Drilling

"There is no compelling reason why the oil and gas reserves which lie under Lake Erie should be tapped immediately.

"There is a compelling reason to preserve the lake water. And there is some danger that oil and gas drilling would add pollution to the lake at the very time when large-scale efforts are underway in Ohio and, indeed, throughout the Great Lakes area to reduce pollution and save the lakes from ruin.

"Therefore, Ohio -- along with Pennsylvania and New York, which also are considering leasing state-owned waters in the lake for oil and gas explorations -- should hold up until it can be proved that science has advanced to the point that pollution will not result.

"Experts testifying on drilling regulations proposed by the oil and gas division of the Ohio Department of Natural Resources expressed grave doubts that pollution could presently be avoided.

"Representative George V. Voinovich of Cleveland proposes calling a halt to proposed drilling until the Ohio House can make a thorough investigation of the pollution threat and until the public can evaluate the risks against the benefits that may be derived from exploiting the oil and gas reserves.

"It is a sensible proposal and has won the support of the resources department, whose chief concern, after all, is protecting the state's natural resources.

"Although drilling has been authorized by the legislature, the department has the power to hold it off by delaying promulgation of regulations. It would be wise to do so until pollution-free operations can be assured."

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"Lake Erie already has the hapless reputation of a 'dead sea,' thanks to the pollution that has ruined its waters.

"Now it is in danger of growing even more polluted through oil drilling. Ohio, New York and Pennsylvania plan to lease submerged Lake Erie lands for oil purposes.

"George Harlow, head of the Lake Erie office of the Federal Water Pollution Control Administration, categorically says there is a pollution threat from the drilling which would take place two to three miles from the shoreline of Ashtabula County.

"Pollution from drilling can come from three sources: the oil itself, brine and the lubricating oil from the underwater machinery.

"On Monday the state will hold hearings in Columbus to discuss the rules for Lake Erie drilling, particularly as it affects shipping and pollution. The oil drillers should be made to prove their case, which may be difficult.

"Certain questions should be asked the proponents of Lake Erie drilling:

"Is the oil which may be obtained absolutely necessary to our economy?

"Will it mean cheaper gasoline to Ohio motorists?

"How will drilling be terminated if pollution occurs?

"Who will pay to clean it up?

"Officials should be wary of such statements as this from a New York official: 'The risk of any of our operations polluting are negligible.'

"Are the risks of a broken oil line negligible? Should such an accident occur, the mess could be as disastrous as the tons of spilled oil that washed the Cornwall coast of England last year.

"And once state officials let the drilling commence, even with tight safeguards ridigly enforced, pollution seems inevitable. This has been part of the tragic history of industrial wastes in Lake Erie.

"It is hard to conceive of any situation which would justify drilling for oil in Lake Erie."

(The following article appeared in The Cleveland Plain Dealer, on Sunday, February 18, 1968:)

"Credibility Gap on the Olentangy, by Richard G. Zimmerman, Plain Dealer Bureau

"Columbus -- Yea, though I walk through the credibility gap, I shall overcome and survive.

"First off, it is easier to keep one's sanity here because fortunately our Ohio credibility gap does not involve the lives of America's fighting men.

"Second, the gap here sometimes gets so wide that one cannot see the size of the abyss and happily forgets he even is plodding along in a deep pit of poppycock.

"Take the flap over whether the state was or was not planning to permit oil and gas drilling in Lake Erie.

"Late last year, Natural Resources Director Fred E. Morr joyously crowed that Ohio was leading other Great Lakes states in opening a portion of Lake Erie to private oil and gas interests.

"And earlier this month, the state held public hearings to discuss a set of regulations to control drilling. A lesser Natural Resources Department official told me immediately after the hearing that advertising material for bids on lake leases was ready to be mailed out to newspapers the same week.

"But apparently reports of public criticism generated by the hearing on regulations were quickly noted in high places, for the next day a top Natural Resources official suggested that I had been drunk on the job for ever suggesting the state had made a decision to permit drilling in the lake.

"At any moment I expect a Natural Resources Department official to appear, swing a watch before my eyes and intone:

"'Repeat after me -- there was no hearing on regulations, there was no hearing on ...'"

(Statement of Ralph S. Locher on behalf of the Izaak Walton League, delivered May 22, 1968, at public hearing held by Ohio Water Pollution Control Board in Cleveland:)

"The Mightiest Little River in the Nation," the Cuyahoga

Introduction

It is a privilege to appear and present testimony for the Izaak Walton League, whose members number dedicated men and women devoted to the cause of conserving our nation's natural resources as defenders of soil, woods, water, and wildlife.

As I look about this chamber, I see the familiar faces of those united in the same cause, many having appeared only two months ago at a meeting in Columbus to oppose the proposed drilling for oil and gas in Lake Erie. Our efforts were, I believe, helpful to the State of Ohio, and I trust can be of further assistance at this important hearing.

The Cuyahoga River has been termed the mightiest little river in the nation. It is a man-made river. Man leveled it out with the great canal, straightened it with the cut at its mouth, dredged it deep for ore bulkers, dammed it at numerous points to harness its power. It is the principal reason for the success of iron, oil, chemical, and rubber empires. Sam Mather, John D. Rockefeller, Ben Fairless, and Cyrus Eaton are associated with the Cuyahoga and its giant industry. (1)

Currently, the value added by manufacture to the products produced in the Cuyahoga Valley is in excess of two billion dollars -- a staggering sum.

Bad Stewards

Why is it that a river which has contributed so importantly to the affluence of the region, should be so foul and neglected? Americans have not been good stewards of nature's bounty. Exploitation of man and resources in our frenzied search for wealth has dominated our being to the end that we are now gravely concerned with whether or not Lake Erie can be saved before catastrophe strikes.

George Harlow of the Federal Water Pollution Control Administration recently stated that Lake Erie may face an instant biological cataclysm which would make the lake's present problems seem mild by comparison.

The American society is a civilization wherein we stand knee-deep in garbage and ankle-deep in sewage, while our fantastic technology sends a man to the moon.

Pollution Abatement -- a Cost of Doing Business

That same technology must be directed by industry and government toward control of industrial wastes. There is hope for the Cuyahoga if two avenues of effort converge:

First, industry must recognize that air and water conservation is a part of the cost of doing business, everywhere in the country. (2)

If a new automobile must cost more by reason of the installation of water pollution controls, the public will understand. Undoubtedly there will be added expense, particularly in the early years for the Republic Steel Company to discontinue its daily dumping of 180,000 pounds of suspended solids, 120,000 pounds of sulfate, 32,000 pounds of chloride, 280 pounds of phenol, 400 pounds of cyanide, 4,100 pounds of ammonia, 1,100 pounds of magnesium, 12,000 pounds of iron and oil and heavy metals.

United States Steel dumps into the Cuyahoga daily: 84,000 pounds total solids, 30,000 pounds suspended solids, 510 pounds of oil, 50,000 pounds of sulfate, 1,000 pounds of chlorine, 15,000 pounds of iron. Jones and Laughlin reports daily discharges of 10,400 pounds of suspended solids, 1,200 pounds of oil, 12,200 pounds of sulfate, 6,600 pounds of iron, 4,900 pounds of chlorides.

Other daily discharges into the Cuyahoga and its tributaries come from: Harshaw Chemical, 550 pounds fluoride, 160 pounds nickel, 3,100 pounds chloride, 30 pounds manganese and sulfate. Ford Motor Company, 62 pounds suspended solids, 62 pounds oil, 43 pounds zirconium dioxide, 2,600 pounds chloride, 410 pounds of silica dioxide (sand). Sunoco Products, 300 pounds suspended solids, 782 pounds of oxygen-consuming material. Rubber Industry -- B. F. Goodrich, Firestone Tire and Rubber, and Goodyear Tire and Rubber discharge unreported quantities of solids, oxygen-consuming wastes, organics and oil into the Cuyahoga at Akron.

Is it any wonder that the Cuyahoga has been described as "one-third mud ... one-third sludge, and one-third pickle liquor ..." (3)

Second, the State of Ohio must request full disclosure of pollution facts from all industry in the state. It is our understanding that some seventeen industries which pollute the Cuyahoga River do not report data on their wastes to the State of Ohio. This is a ridiculous situation, unfair to those industries which do report and an affront to the public of Ohio. Further, the State of Ohio should adequately finance and staff the Ohio Water Pollution Control Board. It is naive to expect that one engineer with no laboratory facilities in Cuyahoga County can monitor the industrial and municipal discharges and singlehandedly enforce state laws.

Massive Federal and State Aid

Estimates to clean up Lake Erie vary from ten billion to twenty billion dollars -- a prodigious sum. Even the lower figure represents $1,000 for every man, woman and child in the area tributary to Lake Erie.

Obviously, the municipalities cannot carry the burden alone. The state and the Federal Government are 100 per cent correct in calling for higher standards and multi-billion dollar programs, but they are wrong in calling the tune without helping defray the costs. So far, the State of Ohio has not invested a nickel in the cleanup of Lake Erie. Not one of the major cities in Ohio has received a penny of federal aid for construction of sewage treatment facilities; although many millions of dollars have been allocated to others.

When the interstate highway system faltered in the 1950s, the automobile and gasoline industries had no trouble ramming through Congress a 90-10 formula; 90 per cent federal dollars and 10 per cent state and local funds. Surely, the fisherman, the boatman, and the family and children who would like to swim in Lake Erie, deserve the same attention from the Congress and the state legislature; and the economic considerations are equally significant. The State of Ohio, to illustrate my point, ten years ago collected 260 million dollars per annum from the sales tax; 24 million dollars was returned to local governments. In 1967, state collections climbed to 369 million dollars, but local governments are still getting only 24 million dollars -- the same as ten years ago.

Citizens' action is required here to convince the legislature to fairly and equitably distribute state tax revenue, as well as to insist that the legislature provide funds to beef up the staff of the Department of Health and the Water Pollution Control Board.

Some Suggestions

The Izaak Walton League, after a cursory reading of the Engineering Report (our copy arrived day before yesterday) respectfully recommends the following:

1. Improved pre-treatment of industrial wastes by industry, particularly the reduction of oils and greases before the wastes empty into the public sewers.

2. Improved operation and expansion of the sewage treatment plants of the various municipalities to provide tertiary treatment at all plants tributary

to streams.

3. Complete treatment at the Easterly sewage treatment plant of City of Cleveland instead of piping sludge to the Southerly treatment plant.

4. Secondary treatment for all water pollution control plants which discharge their effluent into Lake Erie.

5. Compulsory periodic inspection and cleaning of septic tanks to insure operational efficiency and gradual elimination of septic tanks.

6. Cooling towers be constructed by industry to prevent thermal pollution of the Cuyahoga and its tributaries; further, thermal pollution should be expressed in terms of maximums rather than in terms of averages.

7. Lake Erie and its tributaries should not be separately considered; all should be treated as parts of an interacting whole, since the more obvious water degradation has taken place in the tributaries; in other words, a watershed or drainage basin concept, is preferable.

8. It should be clearly understood that initial standards are not final; that standards on water quality will be raised until clean water is the end result, at earliest possible time.

With vigorous enforcement, the Cuyahoga River and its tributaries will return to its former condition and use as a spawning area for warm, fresh water fish-life.

The Waltonian Philosophy

Previously, at the November 30, 1966, hearing held by this honorable body, the philosophy and ideal of the Izaak Walton League was expressed by Seba H. Estill, Chairman of the Conservation Committee, who stated the following:

"We concur in the recommendations of the Ohio Water Pollution Control Board that the waters of Lake Erie proper be made suitable to serve all uses. This could generate hope for a resurrection of Lake Erie's once great commercial fishing industry and a resurgence of its sport fishing, while providing fresh incentives for northern Ohio's once flourishing vacation industry to collaborate in the rebuilding of their industry and the advancement of an enviable image as the outstanding vacation and watering region of our entire midwest.

"However, we believe that the water of harbors (within the Cleveland breakwall, for instance) and similar areas, should also be suitable for body contact purposes. Then Cleveland's bathing beaches might again be open to the public; and that other sports, such as water skiing, might again be engaged in.

"To this end, we request a water quality criteria capable of supporting the propagation of a thriving and healthy population of warm water game fish that are indigenous to the area...."

Thank you for this opportunity to appear on behalf of the Izaak Walton League.

Appendix

Note 1

The red of the water is created by iron, mud, sulphur, crude oil, and pickle liquor from the mills. And for 100 years those who have known which side mid-west bread is buttered on have thanked God ... also Sam Mather, John D. Rockefeller, Ben Fairless, Cyrus Eaton, and many other early iron men who sailed out of the Cuyahoga Basin up to the Michigan, Menominee, and Mesabi Ranges to find the red dirt that feeds Cuyahoga's iron furnaces and colors its waters. (Taken from "The Cuyahoga" by William Donohou Ellis, 1966)

Note 2

Either we voluntarily implement effective pollution abatement programs at all levels of business and industry, or in the near future our actions in this area will be spelled out by Congressional legislation. Today we still have the freedom to make a reasoned and resolute response to the problem. Tomorrow our actions may be tightly controlled by government regulations.

If our efforts are made mandatory, not only will we be forced to take more costly and less efficient action, but we will also forfeit our claim to being a responsible segment of society. To those who say they cannot afford to take effective anti-pollution measure, I can only respond that they can't afford not to. By: Mr. A. Wright, President of the Chamber of Commerce of United States, also Board Chairman of Humble Oil and Refining Co. (Taken from "Industrial Water Engineering" January issue, 1967)

Note 3

Sometimes the old river seems to be a combination of one-third mud from the still rural headwaters, one-third sludge, and one-third pickle liquor from the great mills, but it continues making history. Mile for mile and drop for drop, it is doubtful that it can be matched by any other river. (Taken from "The Cuyahoga" by William Donohou Ellis, 1966)

CHAIRMAN STEIN: Thank you, Mayor Locher. (Applause)

I heard that comment, too, about the dredged material being half water, but I didn't comment, because you didn't say it was clean water but --

Again, let me make the record clear -- and I would like to talk to you people about this, because I do think this is a serious matter. I didn't say that pollution from oil wasn't an important problem. Every time we have a catastrophe or we have a boat sunk -- and we had one that we were talking about just a month or two ago, Mr. Oeming, in Lake Michigan -- this is very, very serious.

The question that I put here -- we have to take the big problems and the small ones, no matter how big or how small. We take the sources -- but even if all this happens, really, sir -- relatively, I am saying the big sources of pollution control in Lake Erie Basin have been and will continue to be -- unless we watch these and put in remedial measures -- are going to be the cities and the industries.

Now, the difficulty that I find in this field -- and goodness knows I am with you on these campaigns, but water pollution control for some reason or other is subject to fantasy. One time we were fooling with the oil well wastes, and talk about that well backfiring -- you should have seen those oil brine things backfire in the old days; we used to have more gushers than wells.

First, it was oil wells. Then, I remember packing houses. Then, pulp and paper wastes. Then, detergents. Then, the pesticides. And now, the three big issues are: radioactive pollution from these mills; thermo pollution and oil pollution -- and there is another one, boat pollution.

Now, all these are very, very important. But I am saying to the people that we must meet these and meet these head on, but let's not lose our perspective, because I have seen more effort get concentrated and more meetings being devoted to these issues to the exclusion of really looking at the bread-and-butter issue of the cig cities and the big industries. That is not to say, Mayor, that we should exclude this oil question as a very serious one, and, as Mr. Lyon knows, we have had numerous discussions on the oil problem, and I have been at these places and up to Cook inlet, and I know what the problems are. As far as I can see they are very serious, indeed, and they have to be handled very, very carefully.

I know you have these stringent regulations when you get on one of these islands in an oil rig and the motor is gone and everything is shaking. Pipes don't always hold together twenty-four hours a day, three hundred sixty-five days a year. It requires a real top maintenance man to do this.

I know this, and with all deference to your statement and what you have said, I think the conferees will carefully consider this, but again I say to you and everyone else: The big problem that we have to face in cleaning up and controlling pollution in Lake Erie is the municipal and industrial sources. If we do that, I do believe we will be able to handle these other things.

MR. LOCHER: Yes, and my paper does go to that. I didn't read it because I wanted it as part of the record. But that is all the more reason, I believe, why dream up and invent sources when we have already got a big enough problem to keep everyone in this room going the rest of their lives?

CHAIRMAN STEIN: That is right.

I have always said, about the dredging, I didn't think we cleaned up one of the Great Lakes just to make it a dump, and your point is very well taken.

Are there any other comments?

Before we go on, we will recess for ten minutes.

(Short recess.)

CHAIRMAN STEIN: I will call on Mr. Metzler from New York.

MR. METZLER: We have the two key people in our organization here, so far as the water pollution abatement is concerned in New York, as it relates to Lake Erie: Assistant Commissioner John C. Haberer, who will make the presentation; Eugene Seebald, who is the Regional

Engineer, is also here, and in the event we get into some detailed questions, he has this very much at his fingertips.

MR. HABERER: Commissioner Stein, conferees, ladies and gentlemen:

I am John C. Haberer, Assistant Commissioner for Pure Waters of the New York State Department of Health.

The following resume will illustrate the status of the program of New York State in water pollution control as it affects Lake Erie.

Of the forty sources of waste discharge to and-or affecting Lake Erie, twenty-two are under formal orders. Of these, twelve are complying with the schedule with respect to formal dates for performance. Thirty-six of the forty are in substantial compliance with the time schedules.

The discrepancy between twelve and thirty-six has been due to problems encountered in the preliminary evaluation of the individual problem. These unknowns have required a readjustment of the original intermediate dates to promote a complete and sound engineering approach. The final dates of abatement have not nor will not be altered without positive engineering evaluation, but the intermediate steps (originally listed in the Commissioner's order in the absence of complete investigations at the problem level) are, and will continue to be, flexible consistent with the problem.

Only four of the forty polluters are regarded as not having realistic terminal dates and two additional ones have been referred to the Attorney General's office for enforcement of the orders.

With respect to the control of bathing areas in New York State bordering Lake Erie, only one formal bathing beach was closed in 1967 (Hamburg Town Park in Erie County). The closing was prompted by high bacteria counts and the unsatisfactory sanitary survey of the area involving particularly effects of stormwater overflows. Changes in bypass and storm overflow arrangements inaugurated by the town of Hamburg have changed the sanitary survey. These steps, coupled with a statistical analysis of the water quality indicate that, in all probability, the beach will be reopened this year under very close health department scrutiny.

The formal listing of other bathing areas on Lake Erie from the Federal Water Pollution Control Administration indicating unsafe bathing areas is an error in that the areas noted do not reflect formal bathing beaches under the acknowledged control of individuals or municipalities.

Six hundred seventy-two samples of Lake Erie water at twenty sites from the mouth of the Niagara River to the New York State-Pennsylvania state line were taken during 1967 from May through September by the New York State, Erie County, and Chautauqua County Health Departments.

The median coliform counts nearly always fell within the statutory coliform limits set by the New York State Legislature in Section 1205 of the New York State Public Health Law and most generally were within the limits of the recommendation No. 9 of the Enforcement Conference dated August 12, 1965.

In the few instances where high coliforms existed for a protracted period, the sampling site was involved with high concentrations of decaying aquatic life and-or in areas receiving high surface run-off from recently occurring rains, flooding storm and sanitary systems into watercourses.

The underwater resources of New York State in Lake Erie (oil and gas) are about to be explored through leases to private concerns under the direction of the New York State Conservation Department with the New York State Health Department exercising surveillance to insure against water pollution resulting from these activities. It is felt that with proper design, construction and control effects, no adverse effects will hinder normal enjoyment of the offshore waters.

John C. Haberer

Any discussion of experiences as to the pollution incidental to offshore drilling operation are, at this time, premature with respect to New York State and its pure waters program.

The disposal of dredged material as a result of the maintenance of navigational channels by the United States Corps of Engineers, particularly in the Buffalo area, has been the source of concern for several years past. A totally enclosed lagoon was used last year to receive dredgings from highly polluted waters. Dredgings from relatively unpolluted water continued to be disposed in offshore Lake Erie water.

A recent application to the New York State Water Resources Commission by the Bethlehem Steel Corporation to permanently dike six hundred twenty acres in Lake Erie adjacent to their plant site near Buffalo has been received. The New York State Department of Health, in its program responsibilities, has conferred with plant management and has made it clear that the taking of underwater land for solid waste disposal must be fully justified on a benefit versus sacrifice evaluation.

The Corps of Engineers has been involved in the conferences and have indicated an interest in the proposal. The area of the solid waste disposal in Lake Erie will all but completely usurp the present authorized offshore dumping site presently being used. The water intakes of the Erie County water authority at Woodlawn and the city of Buffalo may be affected by the shoreline change. The steel company proposed to conduct hydraulic model studies to demonstrate the potential effect on the intakes and the navigation channels adjacent to the area. Any recommendation to the Water Resources Commission by the Health Department with respect to the Bethlehem proposal will be contingent upon the details developed as a result of the further study.

In conclusion, New York has and will continue an aggressive program to insure the integrity of Lake Erie's waters and will administer such controls as are available, consistent with good engineering and public health programming coupled with wise and equitable administration of the vast natural resource of the lake.

ABATEMENT STATUS
(Revised 6/1/68)

POLLUTER NAME & LOCALITY	ACTION REQUIRED & DATE	ACTION TAKEN OR EXPLANATION	ADDITIONAL ACTION REQUIRED
Moench Tannery, Gowanda (V)	Final Plans 6/1/68	The industry together with other industries in the Village of Gowanda and the Village of Gowanda are investigating joint treatment of their wastes.	Continual follow-up and review of material submitted 3/1/68.
Eastern TAnners Glue Div. Gowanda (V)	Commence Construction 4/1/68	Same as above.	Same as above.
Brocton (V)	Commence Construction 4/1/68	Plans have been submitted by the consulting engineers for the Village. Cost estimates indicate excessive cost for municipal undertaking. Industry modifications have altered the scope of the project	Follow-up with consulting engineers.
Dunkirk (C)	Submit final plans 5/1/68	Wastewater facilities report prepared. Field conference held.	Review of report and implementation of project.
Westfield (V)	Submit final plans 6/1/68	Wastewater facilities report submitted. Cost estimates and method of treatment being restudied to provide for adequate treatment consistent with municipal financial ability.	Meeting held 5/23/68 to discuss project with municipal representatives.

POLLUTER NAME & LOCALITY	ACTION REQUIRED & DATE	ACTION TAKEN OR EXPLANATION	ADDITIONAL ACTION REQUIRED
Growers Co-op. Westfield (V)	Submit final plans 6/1/6	Industry indicated desirability to connect to municipal sewers. However, cost estimates indicate excessive costs for joint municipal industrial venture ($5,000,000)	Industry must provide for adequate treatment either alone or in conjunction with the Village. See Westfield (V).
Huntley Mfg. Co. Brocton (V)	Connect to Village sewers as soon as available.	Sewers not available. Follow up. Inspection April 196 revealed insignificant problem. No discharge to surface waters.	
R.C. McAteer Ripley		Inspection 4/68 revealed discharge through municipal sewers of minor pollutional significance.	Follow up. Municipality must provide additional degree of treatment.
Seneca Westfield Maid Westfield (V)	Submit final plans 6/1/6	Industry has indicated desire to connect to municipal sewers. Joint municipal industrial venture delayed because of excessive cost estimates.	Industry must provide, either alone or in conjunction with the municipality adequate waste treatment facilities. See also Westfield (V).
Welsh Grape Juice Brocton (V)	To close 6/67	Only storage of grape juice at the plant at present. Facilities being constructed in Westfield to eliminate need for storage in Brocton.	Continuance of follow-up with industry. See also Brocton (V).
Welsh Grape Juice Westfield (V)	Submit final plans 12/31/67	Industry has indicated desire to connect to municipal sewers However, excessive cost estimates have delayed the project	Continual contact with the industry which must, either alone or in conjunction with the Village, provide for adequate waste treatment faci ities. See also Westfield (V

POLLUTER NAME & LOCALITY	ACTION REQUIRED & DATE	ACTION TAKEN OR EXPLANATION	ADDITIONAL ACTION REQUIRED
Allegany Ludlum Steel Corp. Dunkirk (C)	Commence Construction 3/1/68	Industry is in the process of connecting to municipal sewers and have abated their discharges.	
Twin Cities Asphalt Dunkirk (C)		Abated	
North Collins (V)	Submit preliminary plans 1/1/68	Plans submitted	Review of plans by State Health Department
Producers and Canners Co-op.	Connect to Village sanitary sewers 6/1/63	Plans submitted by the Village for additional treatment of municipal and industrial wastes	Continued contact with the industry and the municipality to provide for adequate additional waste treatment facilities
City Laundry Dunkirk (C)	Connect to City sewers as soon as available	Sewers not yet available	Advise City of need for providing additional sewer collection facilities.
Silver Creek (V)	Plant in operation 3/1/67		Installation of additional collection facilities and connection of individual discharges to the sewer system by the municipality
Silver Creek Preserving Silver Creek (V)	Connect to village sewers before canning season	None.	Field recheck
Bethlehem Steel Corp. Lackawanna (C)	Commence Construction 6/1/63	Portions of the facility have been constructed. Internal modifications have been made in areas within the plant. Investigation of deep well disposal by test well currently underway.	Industry must implement approved plans being developed in phases.

POLLUTER NAME & LOCALITY	ACTION REQUIRED & DATE	ACTION TAKEN OR EXPLANATION	ADDITIONAL ACTION REQUIRED
Socony Mobil Oil	Commence Construction 4/1/68	Refinery scheduled for close down in June of 1968. Investigation reveals facilities to be adequate for storage purposes and terminal use.	State Health Department follow up
Buffalo Dye Works Allied Chemical Corp.	Submit final plan 1/13/68	Plans submitted Joint conference Buffalo Sewer Authority, Industry & State Health Dept.	Health Dept. to review plans. Industry must negotiate with Buffalo Sewer Authority to discharge pretreated wastes to the Sewer Authority system.
Depew (V)	6/1/68 Start Construction	Construction delayed by necessity to comply with Regional plan to permit federal and state grants in aid	
Lancaster (V)	Plant in Operation 6/1/68	Same as above	Same as above
Donner-Hanna Coke Corp. Buffalo (C)	Submit preliminary plan 10/1/67	Plans submitted	Review of submitted plans. Continual contact with industry.
Republic Steel Corp. Buffalo (C)	Submit preliminary plan 4/1/67	Plans submitted. Portions of the final plans have been submitted for facilities.	Continuous follow-up and review of submitted plans.
Hanna Furnace Co. Lackawanna (C)		Investigation reveals minor pollutional significance.	
North Collins (T) Lawton's Hamlet	Submit final plans 4/1/68	Wastewater facilities report submitted.	Continuous contact with municipality and review of submitted plans.

POLLUTER NAME & LOCALITY	ACTION REQUIRED & DATE	ACTION TAKEN OR EXPLANATION	ADDITIONAL ACTION REQUIRED
Growers and Packers Co-op. North Collins (V)		Plant used for storage only--abated	
Fredonia (V) & Red Wing Cannery	Submit preliminary plans 4/1/67	Plans submitted. Not implemented. Submitted to Atty. General for action.	Plans for additional facilities should be implemented.
Dunkirk Conferenceq Grounds Sheridan (T)	Secondary Treatment Required.		Plans required followed by implementation
Holy Cross Seminary	" "		" " "
Ripley Sewer District Ripley (T)	Secondary Treatment Required	Schedule for plant modifications submitted	Implementation of schedules
Hamburg (T) - Master Sewer District	Provide Secondary treatment	Time schedule proposed	Comprehensive study indicates joint project absorbing other Town sewer districts
Wanakah Sewer District Hamburg (T)	Provide Secondary Treatment	" "	" "
Woodlawn Sewer District Hamburg (T)	Provide Additional treatment	" " " "	Comprehensive study indicates joint project with Hamburg Master Sewer District
Mt. Vernon Sewer District Hamburg (T)	Provide Secondary treatment	" "	" "

New York State is sorry that we lost Miss Brockway. We do not have any dancing girls. This completes my presentation.

CHAIRMAN STEIN: Are there any comments or questions?

By the way, John, can we have a list of those communities, or is that in a table?

MR. HABERER: That is in the table.

CHAIRMAN STEIN: Without objection, this will appear in the record as if read. Are there any other comments or questions?

MR. LYON: It is obvious, Mr. Chairman, that Miss Brockway had to move to Pennsylvania because of the beach conditions in New York!

CHAIRMAN STEIN: You know, New York should have spoken earlier because evidently they are going to vie with you for providing oil leases, and maybe some of the opinions would have been directed at New York if they allied themselves with this position. I know Pennsylvania was the stalking horse, but I was interested in one sentence, and I am not quite sure what it means.

MR. HABERER: Cross it out if you don't like it.

CHAIRMAN STEIN: No, you indicate that New York is going to have oil and gas exploration through leases.

Then you say, "Any discussion of experiences as to the pollution incidental to offshore drilling operation are, at this time, premature with respect to New York State and its pure waters program." What do you mean by that? You mean we don't have the pollution yet?

MR. HABERER: Well, we haven't approved the rules and regulations yet, nor have we come close to that. So, we are talking about possibilities.

CHAIRMAN STEIN: In other words, you are really not going to beat Pennsylvania. You are not about to issue a lease until you have these rules and regulations put out.

MR. HABERER: That is right.

CHAIRMAN STEIN: Are there any other comments or questions?

Well, I think we are getting the pollutants laid out. Are there any further questions or comments?

If not, thank you very much, Mr. Haberer.

Mr. Metzler.

MR. METZLER: Unless there are some other questions on the New York statement, this concludes the New York presentation.

CHAIRMAN STEIN: Now, may I make one suggestion? I think New York State, as it does pretty generally, has this program pretty much on schedule.

Now, when you have an adjustment -- and I am not talking about an intermediate adjustment, but an adjustment of the terminal dates, as you may have -- you point out four out of forty as not having realistic terminal dates. Would it be agreeable if you could make that information available to the conferees?

MR. METZLER: We would expect to keep up to date on any changes that would have to be made.

There is one thing that I might point out, just as a matter of interest and not to prolong the conference, but we have used a technique in this area that we had not used prior to the last conference, and that is: The New York statute permits the Commission of Health actually to hold a hearing and to fine a polluter who is not performing, and we carried out such an action at least against one large corporation, and as a part of our overall program of moving swiftly with justice against flagrant violators.

CHAIRMAN STEIN: Now, I have one reservation that I want to hold later for discussion. I am going to at least open the question on the numerical removal of phosphates, whether we think we are all working toward the same end or not.

Specifically, of course, we are going to open up to what Michigan is doing, whether we are asking for eighty percent in all cases, and the question is whether we should or this should be a policy for Lake Erie. We have not done that yet. We left that a little open because of the State of New York.

I think that this -- and particularly in view of the determinations made in other places, such as Lake Michigan -- I am going to ask that question fairly generally later.

MR. METZLER: I don't object to your asking it now, Mr. Chairman, as far as I am concerned.

I think if we are not careful that we will -- first, let me point out that in the one big installation in New York State that is far enough along that we have pretty much good cost data, we are talking about doubling the cost of sewage treatment over the cost -- the phosphate removal cost is as much as the secondary treatment of sewage.

Now, this is not something that you undertake lightly, and at least in the one case where we have moved into preliminary design of facilities we think it is justified.

This is one of the reasons that I was particularly responsive to the model proposal by Pennsylvania. I would really like to know what benefits, if any, we are going to get from the increased phosphate removal. The only reason that we are zeroing in on phosphates like we are --

for those who are laymen in the group -- is because it happens that it is the nutrient that we do know how to take out.

CHAIRMAN STEIN: That is right.

MR. METZLER: Nitrogen may be much more important as far as stopping the algal blooms that we are all worrying about, and I am quite concerned that we say to the big cities -- Cleveland, Detroit, and Buffalo, and the small communities -- we are going to double your costs of waste treatment before you even get up to the secondary treatment level.

CHAIRMAN STEIN: Let me just --

MR. METZLER: So, in answer to this question I would hope that we would defer any formal recommendations on this matter, refer it to a technical committee to take a look at and perhaps see us in the future.

CHAIRMAN STEIN: This is for clarification.

I have heard the same figures, Mr. Metzler, and as I understand it, when they are talking about doubling the cost, they didn't mean in capital improvements, but in operations..

MR. METZLER: The figure I was using was doubling the operating costs, that is correct.

CHAIRMAN STEIN: Mr. Poole.

MR. POOLE: I wanted to ask New York the same question Mr. Metzler asked Indiana, and that is: Will the availability of Federal grants have anything to do with your keeping with your timetable and schedules?

MR. METZLER: That is a real tough question and I am going to give you a different answer than you have heard elsewhere. It will hurt us financially. It will hurt our communities, and it makes promotion much more difficult, but we are committed on a course in which we will prefinance the Federal Government thirty per cent of the project cost as well as finance the State's share, and we are prepared with a bond issue to finance sixty per cent of the construction costs.

We are not willing to let New York communities wait to start their construction, or to complete their construction until Congress makes up its mind. (Applause)

CHAIRMAN STEIN: Are there any other comments or questions?

MR. LYON: On the phosphate question or --

CHAIRMAN STEIN: Anything. You can choose.

MR. LYON: Well, Mr. Metzler mentioned that we should have a technical committee on the phosphate question, and we did have a technical committee on this, but I frankly can't remember whether they recommended any specific phosphate removal or not.

CHAIRMAN STEIN: Here we came up with a

substantial removal of phosphates, as I recall it, and at Lake Michigan we came up with a minimum of eighty per cent removal of phosphates, but I think if you will look at the conclusions of the conferees, based on that, we come up with substantial removal.

Again, as I recall -- and I think I recall this fairly well -- the other conferees check me -- one of the problems that we had with specifying a number at the earlier conference was the state of the art: We couldn't come up with figures, and so forth.

After Lake Michigan, the cost figures have been pretty well zeroed in on. We have been conducting meetings for engineers and others where our technical staff is going over the techniques of phosphate removal and cost figures.

Several of the chemical firms and other firms in the business, I understand, have techniques and products to accomplish this, and certainly without being specific as to anyone, I understand these are reliable companies. They have reliable technicians and the methodology works.

In other words, the specifics for phosphate removal are not that much of a mystery anymore, and I think we are committed, at least on the phosphate removal, and I agree with Mr. Metzler, this is on a theory.

The theory is that if you remove one of the essential nutrients -- the same as if you are fertilizing your lawn -- nitrogen, potash, and phosphates -- you are going to inhibit the growth of algae and weeds and plankton, and so forth, that require these elements to grow. The notion is: You don't need much potash, that nitrogen is ubiquitous -- try and keep it out! Even if you did, you would get it in from the air. The phosphates are the one thing that we can control and experiments have been made to show that there is a critical level of phosphorous and when this critical level is not reached the growth really drops.

Now, again, I share Mr. Metzler's notion. We are dealing with a whole lake and a very complex situation, and this is to quote Jerry Remus: Before you get $200 million or half a billion dollars on something, you want to be pretty darn sure it is going to work.

MR. LYON: Mr. Chairman, since Michigan has assumed the leadership in proposing eighty per cent phosphate removal for its sources, and since Michigan is the major source of phosphates, why don't we consider adopting their percentage removal for the rest of the States and see how that fits?

CHAIRMAN STEIN: Why don't you think about that? The reason I just opened this up, I think this should come up for discussion after Ohio finishes its presentation, but I do think that this is the key point, and we will get to that later. I didn't want to cut off the discussion. I think it would be more orderly to go on -- Mr. Metzler, has New York completed its presentation?

MR. METZLER: New York has completed its presentation. I would point out the last time we conferred on this matter we did have three recommendations. They were all aimed at the fact that the technology wasn't there, that the process is needed to be developed, and the phosphates which were removed by treatment should not be returned to the water system; but we would have quite a leap to make from the position where we were a year ago to a conclusion now at eighty or ninety or ninety-two per cent phosphorous removal.

CHAIRMAN STEIN: Well, I think, again -- and maybe we should have had these people here -- that you decide this -- that our technical people indicate that the technological gap has been closed.

Now, you have to make your own judgment on that. Those were the statements we got from our people, and according to them it is merely a question of cost, and their prognosis is that the costs are going to keep growing very, very moderately as we go on. This is something you would have to --

MR. METZLER: It is also true that the costs they are projecting are great enough to make drinking water out of sewage, I just want to make sure that the citizenry who are going to pay for this understand the magnitude of what we are talking about.

CHAIRMAN STEIN: The difficulty of the lakes and their cost is: Even if we make drinking water out of sewage discharges and leave the phosphates in, you are still going to have the eutrophication problem.

I am not drawing any conclusion. This is for the conferees and the point is: I do think that our technical staff believes they have definitive answers now that they didn't have last time. You may want to listen to their presentation for your evaluation as to how definitive these answers are.

Mr. Eagle, may we have Ohio's report?

MR. EAGLE: Thank you, Mr. Chairman, I thought you were never going to ask me.

CHAIRMAN STEIN: And you are the host State!

MR. EAGLE: Mr. Chairman, conferees, ladies and gentlemen:

My name is George H. Eagle. I am the Chief Engineer of the Ohio Department of Health. My Division of Engineering serves as the technical staff of the Ohio

Water Pollution Control Board, and I submit this report for the conferees and the Board, and I wish to submit this report in its entirety for the record. However, I will only read parts of it.

CHAIRMAN STEIN: Without objection, this report will be included in the record as if read.

(The above-mentioned report follows.)

MR. EAGLE: Since the fourth meeting on pollution on Lake Erie, held in Buffalo on March 22, 1967, the Ohio Water Pollution Control Board has taken the following actions relative to the establishment of water quality standards:

1. On April 11, 1967, adopted water quality standards for Lake Erie and the interstate waters thereof (See Appendix II);

2. On June 13, 1967, adopted water quality standards for the Ashtabula River, Conneaut Creek, and Turkey Creek which are interstate tributaries of Lake Erie (See Appendix II);

3. On November 14, 1967, adopted water quality standards for the following intrastate tributaries of Lake Erie: The Portage River, the Sandusky River, the Huron River, the Vermillion River, the Black River, and other tributaries of Lake Erie from Maumee Bay on the west to the Black River on the east (See Appendix II); and

4. On May 22, 1968, held a public hearing on

water uses and water quality criteria for the Rocky River, the Cuyahoga River, the Chagrin River, and the Grand River (See Appendix II for Conclusions and Recommendations of the Division of Engineering).

In addition, I wish to submit for the record the water quality standards for the interstate and intrastate waters of the Maumee River and its tributaries, adopted by the Ohio Water Pollution Control Board on January 10, 1967 (See Appendix II).

With the adoption of water quality standards for the Rocky, Cuyahoga, Chagrin, and Grand Rivers and their tributaries, which is expected to be done by the Board in the next few months, the establishment of standards for the entire Ohio portion of the Lake Erie basin will have been completed.

You will note the Lake Erie water quality standards adopted by the Board on April 11, 1967, include two important recognitions of the 1965 Recommendations and Conclusions of these conferees:

1. "Lake Erie Water Quality Criteria for Various Uses are:

"1. the stream water quality criteria for various uses adopted by the Ohio Water Pollution Control Board on June 14, 1966, which shall apply as a minimum to all Lake Erie waters in Ohio, and

"2. the existing lake water quality which shall apply where better than the criteria for streams adopted by the Board. The existing lake water quality shall be as reported by the Federal Water Pollution Control Administration in the chapter on Water Quality in report 'Program for Water Pollution Control - Lake Erie - 1967.'

"Lake Erie outside the established harbors at Lorain, Cleveland, and Ashtabula shall meet the Lake Erie water quality criteria for all uses.

"The Lorain, Cleveland, and Ashtabula harbor waters in Lake Erie shall meet the Lake Erie water quality criteria for industrial water supply and aquatic life A."

and the implementation and enforcement plan;

2. "The 'Recommendations and Conclusions, August 12, 1965' agreed upon by conferees from Michigan, Ohio, Indiana, Pennsylvania, New York, and the United States Public Health Service following conference under Section 8 of the Federal Water Pollution Control Act in the matter of pollution of the interstate and Ohio intrastate waters of Lake Erie and its tributaries held in Cleveland, Ohio, August 3-6, 1965, and in Buffalo, New York, August 10-12, 1965, and 'Report of the Lake Erie Enforcement Conference Technical Committees, March, 1967' are included as a part of this program insofar as applicable to Lake Erie waters

in Ohio."

I believe these adoptions speak for themselves with regard to furtherance of the conferees recommendations and conclusions.

Following is Ohio's status report on the applicable items in the Recommendations and Conclusions of August, 1965:

WASTE TREATMENT

Secondary Treatment (Items 7 and 22)

Following is a summary of status of schedules placed in effect by the Board (See Appendix I for detailed listings):

	5/68	3/67
1) Number of adequate municipal and county secondary treatment facilities completed and placed in operation since August, 1965	18	8
2) Number of Municipalities, Counties and other entities not having adequate secondary treatment facilities at this time	85	88
a) Under construction - completion in 1968	10	25
b) Construction to be completed not later than end of 1969	56	44
c) Construction to be completed not later than end of 1970	15	16
d) Construction to be completed not later than 1971	3	1
e) Construction to be completed not later than end of 1972	1	-
Total	103	96

You will note that ten new or improved secondary wastewater treatment plants have been placed in operation since our March, 1967, meeting. However, a number of the plants scheduled for completion this year had to be moved up to 1969 and later, primarily because of problems of completing the plans and of litigation.

All of the schedules for the 103 entities reported on have been included in Water Pollution Control Board permit conditions. The permit conditions are regularly reviewed by the staff and the Board. Many municipalities and counties have been brought before the Board for show cause hearings and many more will probably have to be brought in before the program is completed.

Disinfection (Item 9)

As previously reported, where feasible all sewage effluents being discharged to Lake Erie are required to be disinfected to meet the public water supply and recreation waters criteria. Where not feasible at this time, the municipalities and counties are required to incorporate the necessary facilities in their plans for secondary treatment or improvements. Four such proposals have been approved recently.

Removal of Phosphates (Items 7 and 8)

Under date of March 28, 1968, the Ohio Department of Health issued a directive to all municipal and county officials and designing engineers to the effect that in the future all plans, both general and detail, of treatment plant improvements submitted to the Department for approval must make provisions for phosphate treatment or removal (See Appendix II).

All of the major municipalities and counties are continuing to study their phosphate problems in existing plants. Several, notably Cleveland Easterly, Toledo, Lake County Willoughby-Mentor Sewer District, Cuyahoga County Rocky River Sewer District, and Painesville, either are or plan in the very near future to make extensive studies of phosphate removal in their plants.

Bypassing and Combined Sewers (Items 10 and 11).

An increasing amount of emphasis is being given by the Division of Engineering, Ohio Department of Health and the Ohio Water Pollution Control Board to sewer construction, complete separation of new storm and sanitary sewers, and solving of combined sewer overflow problems. In addition to the directive on separation of sewers reported in June, 1966, another directive on sewer construction was issued on February 1, 1968 (See Appendix II).

Wapakoneta, Lima, Toledo, Findlay, Cleveland, and several other municipalities and counties are having engineering studies made of their combined sewer and sanitary sewer overloading problems.

There are two interesting proposals under consideration at Cleveland:

One, a holding lagoon in Lake Erie at the Easterly water pollution control works for retention of combined sewer overflows, plant effluent, and stormwaters, and

Two, an enclosed bathing beach area in Lake Erie where all discharges to the area are regulated and chlorinated and the lake waters within the area are chlorinated as required to meet bathing water criteria.

George H. Eagle

Industrial Wastes (Item 16)

Following is a summary of the status of the required treatment or reduction facilities. The details are given in Appendix I.

	5/68	3/67
1) Number of facilities completed and placed in operation since August, 1965	28	13
2) Number of industries not having adequate treatment or reduction facilities	62	82
a) Under or near under construction-completion in 1968	6	26
b) Construction to be completed not later than end of 1968	24	28
c) Construction to be completed not later than end of 1969	32	28
Total	90	95

The total number of industry entities has decreased since March 1967 because of plant relocations, discontinuation of certain processes, and various other such reasons.

You will note that the schedules as previously reported are being fairly well maintained.

All schedules shown in the tables in Appendix I are included in the permit conditions issued by the Ohio Water Pollution Control Board. These permit conditions are reviewed regularly by the staff and the Board.

Sampling and reporting of industrial waste discharges (Items 13, 17, and 18)

These programs are continuing as reported at the fourth meeting in March 1967. Some problems in connection with data processing have arisen and a consulting firm has recently been employed to assist us. We hope by the end of this calendar year to have all our data as well as that received from other sources on a satisfactory processing system.

Surveillance (Item 19)

The State of Ohio is participating in three water quality monitoring programs for the surveillance of Lake Erie and its tributaries.

1. A contract between Ohio and the Water Quality Branch of the United States Geological Survey has

established 11 automatic monitoring stations on Lake Erie tributaries. Five additional monitors will be in operation before July 1, 1968. Twelve stations are equipped to measure specific conductance, temperature, pH, and dissolved oxygen. The remaining four stations are three parameter monitors providing measurement for specific conductance, temperature, and pH.

2. The Ohio Department of Health cooperating jointly with the Federal Water Pollution Control Administration has developed a water quality program involving seventeen municipal water treatment plants which use Lake Erie as a source of public water supply. Combined efforts of the municipal, State, and Federal laboratories provide for thirty parameters to be run on Lake Erie water. Sampling intervals vary somewhat and include continuous, daily, bi-weekly, bi-monthly, and monthly measurements.

3. Twenty-five additional water quality stations are operated by the Ohio Department of Health in the Lake Erie drainage basin. Twenty-two types of analyses are run on both surface and well sources including measurement of pesticides or chlorinated hydrocarbons and ionizing radiation. In addition, all municipal water treatment plants and wastewater plants perform raw water analysis daily and report to the Department of Health on a monthly basis.

4. The staff of the Ohio Department of Health is working with local agencies, primarily health departments on programs for adequate surveillance of all Lake Erie bathing beaches. It is hoped that these programs will be in full operation by not later than the 1969 bathing season.

Disposal of Refuse (Item 14)

New Legislation.

Legislation to control the disposal of solid wastes was enacted by the Ohio General Assembly and became effective December 14, 1967. The salient features of the new law (Sections 3734.01 to 3734.11 inclusive, and Section 3734.99 of the Ohio Revised Code) are:

1. Grant the Public Health Council (State Board of Health) authority to adopt regulations having uniform application throughout the State. These regulations would establish minimum standards for the location and operation of all solid waste disposal sites and facilities, including those installed to dispose of wastes from domestic, commercial, agricultural and industrial establishments.

2. Provide for approval by the Department of Health of plans, facilities, equipment and supplies for all solid waste disposal sites and facilities.

3. Require annual licensing of all disposal sites and facilities.

4. For all intents and practical purposes, prohibit open dumping and open burning.

5. Provide for inspection and policing of all solid waste disposal sites and facilities by the local and State health departments.

6. Provide for penalties or injunctive action against any person, firm, or corporation, whether public or private, for failing to comply with the provisions of the law or the regulations adopted pursuant thereto.

Regulations adopted pursuant to authority granted by Section 3734.02 of the Solid Wastes Disposal Laws were passed by the Public Health Council following a public hearing held on May 18, 1968. The effective date of the regulations is July 1, 1968.

In addition to the Solid Wastes Disposal Law described above, the Ohio General Assembly also enacted Section 3767.32 and 3767.33 of the Ohio Revised Code which sections became effective September 21, 1967.

These new sections of Ohio law prohibit the disposing of solid wastes of any kind in any manner along the banks of or into any waters of the state.

The basic prohibitions of Section 3767.32 are incorporated in the regulations adopted by the Public Health Council on May 18, 1968 (effective July 1, 1968).

Actions. 652

George H. Eagle

All of the eight dumps reported on at the fourth meeting of the conferees, either have been abandoned or are in the process of being brought up to sanitary landfill standards. The new legislation requires that all work be completed by January 1, 1969, at which time they will be placed under license or ordered to be closed.

APPENDIX I

1. Municipal and County Waste Treatment Facilities

   (Exhibits A-D, inclusive - Schedule of City of Cleveland, Ohio)

2. Industrial Waste Treatment Facilities

KEY TO ABBREVIATIONS

Treatment Facilities - Pr. = Primary
Int. = Intermediate
Sec. = Secondary
D = Disinfection by chlorination

S.D. = Sewer District of County

Type Sewer System

S = Separate
C = Combined

U.C. = Under Construction

I.P. = Plans being ~~repaired~~

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIÉ DRAINAGE AREA IN OHIO
BLACK RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities						
Avon	7,651	French Crk	S - Sec. 800 PE (Part of City)	1955	New treat. facils (secondary) for entire city.	Detail Plans 6-15-68 Construction 12-15-69
Lorain	76,910	Black R.	S - Pr+D 100,000 PE	1956	Improvements - secondary treat.	Rep.& G.Plan 3-15-67 (Yes) Detail Plans 6-20-68 Construction 12-15-70

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
CHAGRIN RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Villages						
Aurora	4,725	Chagrin R.	S - Sec. 2,500 PE	1928	Improvements -	Rep.& G.Plan - Approved Detail Plans 4-15-67 (Yes) Construction 10-15-69
Sewer Districts						
Geauga County						
Bainbridge Twp, S.D.#2 Ravenwood Subdiv.		McFarland Creek, Chagrin R.	S - Sec. 100 PE	1966	None	In oper. 1966
Bainbridge Twp. S.D.#3		Chagrin R.	No public sewers.	-	Sewers & connection to Chagrin Falls sewer system.	Negotiations underway.

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
CUYAHOGA RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities						
Akron	298,052	Cuyahoga R.	S-Sec.+Prechl. 330,000 PE	'29,'57	Addtnl treat.facils (Phase I - addtnl second.treat.) (Phase II - addtnl primary treat.)	Phase I - Under construct. Phase II--Det.Pl.9-15-67 Construction early 1970 (No I.P.)
Cleveland	858,823 + 484,423 21 Trib.Munic's	Cuyahoga R.	S & C Southerly Sec. 680,000 PE	'27,'38,'56	Addtnl treat.facils	See attached schedule - City of Cleveland
Independence	7,769	Cuyahoga R.	No public sewers.	-	New treat. facils - secondary.	Rep.&G.Plan 6-15-67 (Yes) Detail Plans 6-15-68 Construction 12-15-69
Kent	23,286	Cuyahoga R.	S - Sec.+D 53,000 PE	'54,'66	Complete construct. second.treat.facils.	6/67 (Yes)
Maple Heights	34,612	Swan Crk	S - Sec.+D 10,000 PE	1955	Complete construct. new facils - second.	4/67 (Yes)
Solon	8,032	Trib.of Cuyahoga R.	S - Sec.+D 7,000 PE 7,800 PE-New	1962	Complete construct. new N.E. facils.	9/67 (Yes)

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
CUYAHOGA RIVER BASIN - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Villages						
Mantua	1,239	Cuyahoga R.	S - Sec. 1,000 PE	1915	New Treat. facils - secondary.	Under construct. 4/67 (Yes)
Middlefield	1,566	Trib.of Cuyahoga R.	C - Pr. 1,800 PE	'54,'57	Improvements - secondary treat.	Detail Plans 6-15-67 (Yes) Construction 8-15-68
Munroe Falls	2,849	Cuyahoga R.	- 2,849 PE	-	Sewers and connection.	Part of Summit County Mud Brook Project.
Northfield	3,156	Trib's of Cuyahoga R.	S - Sec.+D 5,965 PE	'59, '65	None	Improvements completed 1965.
Oakwood (Cuyahoga Co.)	3,283	Trib.to Tinkers Crk	S - Prim. 200 PE	1940	New treat. facils - secondary.	Rep.& G.Plan 3-15-67 (Yes) Detail Plans 7-15-67 (No) Construction 9-15-68
Sewer Districts						
Cuyahoga County						
Brecksville S.D.#13 (Brecksville)		Cuyahoga R.	S - Sec.+D 10,000 PE	1962	Improvements - addtnl treat.facils.	Rep.& G.Plan 12-15-67 (Yes) Detail Plans 1-15-69
Brecksville S.D.#13 Southern Estates		Cuyahoga R.	S - Sec.+D 300 PE	1966	None	Completed in 1966.
Portage County						
Aurora Acres S.D.		Trib.of Tinkers Crk	S - Sec.+D 400 PE	1958	None	
Ravenna S.D.#1 Lakeview Gardens Allot.		Breakneck Creek	S - Sec.+D 200 PE	1963	None	

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
CUYAHOGA RIVER BASIN - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Portage County - contd.						
Shalersville S.D.#2 Bolingbrook Allot.		Cuyahoga R.	S - Sec.+D 128 PE	1960	None	
Streetsboro S.D.#2 Rolling Hills Acres		Trib.of Tinkers Crk	S - Sec.+D 400 PE	1961	None	
Summit County						
Munroe Falls S.D. Plant #11		Trib.of Cuyahoga R.	S - Sec.+D 150 PE	1961	None	
Northampton SD-Plant #2 Hidden Valley Subdiv.		Trib.of Mud Brook	S - Sec.+D 400 PE	1958	None	
Northampton SD-Plant #3 Bellridge Subdiv.		Trib.of Mud Brook	S - Sec.+D 200 PE	1959	None	
Northeast SD-Plant #9 Macedonia Estates		Brandywine Creek	S - Sec.+D 300 PE	1961	None	
Stow Twp. SD-Plant #4		Cuyahoga R.	S - Prim. 2,000 PE	1924	Construction of Interc.Project*	Bids taken 5-1-67 (Yes) U.C. 1-2-68

* - Summit Co.-Mud Brook Interc.Proj.-Det.Plans apprvd & Fed.Grant Offer made.

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
GRAND RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
City						
Painesville	17,689	Grand R.	S - Int.+D 24,326 PE	1958	Improvements - secondary treat.	Rep.& G.Plan 12-31-67(No IP)*1 Detail Plans 9-30-68 Construction 12-31-70
Villages						
Fairport Harbor	4,260	Grand R.	S - Int.+D 6,000 PE	1958	Improvements - secondary treat.	Rep.& C.Plan 7-15-67(No IP) Detail Plans 5-15-68(No) Construction 10-15-70
Grand River	477	Grand R.	No public sewers.	-	New treat. facils - secondary.	Detail Plans 12-15-67(No.IP) Construction 12-15-69
Orwell	830	Grand R.	No public sewers.	-	New treat. facils - secondary.	Detail Plans 3-15-67(Yes) Construction 11-15-68 UC
Sewer Districts						
Lake County						
Concord S.D. Little Mtn Park Subdiv.		Kellogg Creek	S - Sec.+D 400 PE	'62,'65	None	
Leroy S.D. Sunshine Acres Subdiv.		Trib.of Big Creek	S - Sec.+D 250 PE	1963	None	
Willoughby-Mentor S.D. Beaver Creek Colony		Kellogg Creek	S - Sec.+D 200 PE	1963	None	

*(1) Study re: secondary underway

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
GRAND RIVER BASIN - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Trumbull County						
Warren Champion S.D. Subdistrict 1-A Durst Allotment		Trib.of Center Crk	S - Sec.+D 400 PE	1961	None	

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STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
HURON RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities						
Huron	6,462	Huron R.	S & C (2 Plts) Int. + D 6,400 PE 2,100 PE	1964 '31,'64	Improvements - secondary treat.	Rep.& G.Plan 6-15-67 (No) Detail Plans 6-15-68 Construction 11-15-70
Norwalk	14,194	Rattlesnake Creek	S & C Sec. + D 26,000 PE	'32,'64	Improvements - addtnl second.treat.	Construction 12-15-68 U.C.
Villages						
Milan	1,563	Trib.of Huron R.	S - Pr. 600 PE	'41,'62	New treat. facils - secondary.	Bids 3-22-67 (Yes) U.C.
Monroeville	1,413	W.Branch	C - Pr.+D 1,700 PE	1959	Improvements - secondary treat.	Rep.& G.Plan 6-15-67 (Yes) Detail Plans 6-15-68 Construction 12-15-69
Plymouth	1,953	Huron R.	C - Sec. 2,400 PE	1966	None	Construct.complete 1966

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
MAUMEE RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities						
Defiance	16,058	Maumee R.	S & C-Int.+D 23,000 PE	1957	Improvements - secondary treat.	Detail Plans 9-15-67 (No IP) Construction 8-15-69
Delphos	7,404	Jennings Creek	C - Sec.+D 7,500 PE	'31,'55	Improvements - addtnl treat. facils.	Rep.& G.Plan 3-15-68 (No IP) Detail Plans 3-15-69 Construction 9-15-70
Findlay	34,061	Blanchard River	S & C - Sec. 30,000 PE	'31,'54	Improvements - (incl.disinfect.)	Rep.& G.Plan approved Detail Plans 7-15-67 *(1) Construction 6-15-69
Perrysburg	6,553	Grassy Crk	C-Int.+Prechl.	1959	Improvements - secondary treat. & disinfect.	Rep.& G.Plan 6-15-67 (No IP) Detail Plans 6-30-68 Construction 12-31-69
St. Marys	8,275	St.Marys River	S - Sec. 22,900 PE	1949	Improvements - (incl.disinfect.)	Detail Plans 6-15-67 (Yes) Construction 6-15-69
Toledo	363,297	Maumee R.	S & C - Sec.+D 420,000 PE	'31,'59	Improvements - Sludge Hand.Facils - Treat.Facils -	Under Constr. 2/67 Rep.& G.Plan 7-15-67 (Yes) Detail Plans 8-15-68 Construction 2/72
Van Wert	11,684	Trib's to Auglaize R.	S & C - Sec.+D 24,200 PE (BOD) 12,450 PE (S.S.)	'35,'36	Improvements - addtnl treat.facils.	Rep.& G.Plan 5-15-67 (No IP) Detail Plans 8-15-68 Construction 12-15-69

*(1) Detail Plans approved 12-29-67

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
MAUMEE RIVER BASIN - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Villages						
Antwerp	1,614	Maumee R.	S & C No Treat.	-	New facils - incl.second.treat.	Rep.& G.Plan 6-15-67 (Yes) Detail Plans 6-15-68 Construction 12-15-69
Columbus Grove	2,150	Trib.of Auglaize R.	S - Sec.+D 5,000 PE	1937	Improvements - addtnl treat.facils.	Now under construction. Construction 12-15-67 (Yes)
Cridersville	1,210	Trib's to Auglaize R.	S - Sec. 2,000 PE	1966	None	Treat.facils completed 1966.
Elida	1,412	Ottawa R.	C - Sec. 3,000 PE	-	Complete new facils incl.second.treat.	Under construction - In operation 7/67. (Yes)
Forest	1,370	Trib.of Blanchard R.	S & C	-	Complete new facils incl.second.treat.	Under construction - In operation 6/67. (Yes)
Hamler	648	Turkeyfoot Creek	No public sewers.	-	New facils incl. secondary treat.	Detail Plans 5-15-68(No IP) Construction 12-15-69
Haskins	542	Haskins Creek	S - Pr. 200 PE	1939	Improvements - secondary treat.	Rep.& G.Plan 5-15-67 (NO) Detail Plans 7-15-68 Construction 12-15-69
Holgate	1,482	Trib.of Turkeyfoot Creek	No public sewers.	-	New facils incl. secondary treat.	Detail Plans 3-15-67(No IP) Construction 5-30-68
Liberty Center	924	Dry Crk	No public sewers.	-	New facils incl. secondary treat.	Rep.& G.Plan 9-15-67 (Yes) Detail Plans 7-15-68 Construction 12-15-69

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
MAUMEE RIVER BASIN - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Villages - contd.						
Montpelier	4,259	St.Joseph River	C - Prim. 5,150 PE	1958	Improvements - secondary treat.	Detail Plans 2-15-68 (No IP) Construction 12-15-69
Northwood	3,843	Grassy Crk	No public sewers.	-	Negot.agreements with Toledo and Wood County for sewer connect.to city sewer system.	Report by 9-15-67 - (Yes) Now in County Sewer Dist.
Ohio City	856	Trib's to Auglaize R.	No public sewers.	-	New facils incl. secondary treat.	Detail Plans 8-1-67 (Yes) Construction 12-15-68
Ottawa	3,475	Blanchard River	C - Sec.+D 5,800 PE	1955	Improvements - addtnl capacity.	Rep.& G.Plan 7-15-67 (Yes)
Pandora	803	Trib.of Blanchard R.	No public sewers.	-	New facils incl. secondary treat.	Detail Plans - approved Construction 1-15-69
Payne	1,324	Trib.of Auglaize R.	C - Sec. 2,700 PE	-	New facils incl. secondary treat.	Under constr. early 1967 (Yes) In operation early 1968
Rockford	1,172	St.Marys River	C - Prim. 1,240 PE	1959	Improvements - secondary treat.	Rep.& G.Plan 9-15-67 ← (No) Detail Plans 4-15-68 Construction 8-15-69
Sherwood	649	Trib.of Sulphur Creek	No public sewers.	-	New facils incl. secondary treat.	Rep.& G.Plan 8-15-67 (No) Detail Plans 5-15-68 Construction 9-15-69

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
MAUMEE RIVER BASIN - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Villages - contd.						
Stryker	1,281	Trib.of Tiffin R.	C - Sec. 1,600 PE	1965	None	Treat.facils completed 1965.
Waterville	2,175	Maumee R.	C - Sec. 1,500 PE	1958	Improvements to treatment facils.	Rep.& G.Plan 7-15-67 (No) Detail Plans 7-15-68 Construction 12-15-69
West Leipsic	340	Trib's to Beaver Crk	No public sewers.	-	Financial problem - to make tributary to Leipsic.	
Weston	1,120	Tontogany Creek	C - Sec. 1,500 PE	-	Constr.of facils pending.	12/66 Bids over estimate; financial problem. UC 12/67
West Unity	1,550	Trib.of Tiffin R.	No public sewers.	-	New facils incl. secondary treat.	Detail Plans 6-15-67 (No) Construction 12-15-69
Leipsic	1,844	Trib. of Maumee R.	C - Sec. 2,500 PE	1938	None	

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
OTTAWA RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
City						
Sylvania	7,650	Tenmile Crk	S - Sec.+D 3,000 PE	1957	Flow in excess of plant capac.to be discharged to Toledo sewer syst.	Construction complete by 6/67 (Yes)
Sewer Districts						
Lucas County						
Metropolitan S.D. Holland Subdist.		Trib.of Maumee R.	No public sewers.	-	New facils incl. secondary treat.	Rep.& G.Plan 3-15-67 (Yes) Detail Plans 6-1-67 (No) Construction 1-15-69
Metropolitan S.D. Sylvan Woods Subdiv. (Sewer #459)		Trib.to Tenmile Creek	S - Sec.+D 600 PE	1966	None	

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
PORTAGE RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
City						
Port Clinton	7,352	Portage R.	S & C-Int.+D 15,000 PE	1956	Improvements - secondary treat.	General Plans Approved 3-21-67 Detail Plans 6-15-67(No IP) Construction 4-15-69
Villages						
Bloomdale	703	S.Branch Portage R.	No public sewers.	-	New facils incl. secondary treat.	General Plan (Yes) Detail Plans 2-15-68 (NO) Construction 12-15-69
Elmore	1,360	Portage R.	Misused storm drains.	-	New facils incl. secondary treat.	Detail Plans 12-15-67 (Yes) Construction 12-15-69
McComb	1,269	N.Branch Portage R.	S & C-Pr.+D 1,000 PE	1937	Improvements - secondary treat.	Detail Plans - approved(Yes) Construction 12-15-68
Oak Harbor	3,128	Portage R.	S - Pr.+D 4,000 PE	1958	Improvements - secondary treat.	Rep.& G.Plan 8-15-67(No IP) Detail Plans 8-15-68 Construction 12-15-69
Pemberville	1,278	Portage R.	Misused storm drains.	-	New facils incl. secondary treat.	Rep.& G.Plan 6-15-67 (Yes) Detail Plans 12-15-68 Construction 12-15-69
Woodville	1,878	Portage R.	Misused storm drains.	-	New facils incl. secondary treat.	Rep.& G.Plan 8-15-67(No IP) Detail Plans 8-15-68 Construction 12-15-69
Other Entity						
Camp Perry		Lacarpe Creek	S - Sec.+D 15,000 PE	1942	None	
1966 data-North Baltimore	3,150	S.Br. Portage R.	C - Sec. 3,500	1960	None	
Bowling Green	17,753	Poe Ditch	S,C - Sec.+D 59,127	1961	None	

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
ROCKY RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities						
Berea	19,643	E.Branch Rocky R.	S - Sec.+D 20,000 PE	'36,'51 & '65	Improvements - addtnl treat.facils.	Under construct. 1967 (Yes) Construction 6-1-69
Broadview Heights	8,588	Trib.of Rocky R.	No public sewers.	-	New facils incl. secondary treat.	Detail plans 1-1-68 (No IP) Construction 12-31-70
Lakewood	70,209	Rocky R.	S-C Sec.+D 130,000 PE	1965	None	Completed new plant 1965 (Yes)
Middleburgh Hts.	9,911	Abram Crk	S - Sec. 2,000 PE	1950	New facils incl. secondary treat.	Bids 4-9-67 Under construct. 5/67 (Yes) Construction 12/68
					(Same as Cuyahoga Co.-Middleburgh Hts. S.D.)	
North Royalton	11,101	Baldwin Crk E.Branch Rocky R.	S-(2 Plts) Sec.+D Total 11,400 PE	1966	-	(Detail Plans for *(1) Sew.Dist."C" to be revised.)
Strongsville	11,502	E & W Branches Rocky R.	S-(3 Plts) Sec.+D Total 7,347 PE	1966	-	Construction completed (Yes) in 1966.
Village						
Olmsted Falls	2,284	Plum Crk W.Branch Rocky R.	Misused storm drains.	-	New facils incl. secondary treat.	To advertise for bids 5/67 (No) Construct 8-69

*(1) To connect to County Trunk Sewer

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
ROCKY RIVER BASIN - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Sewer Districts						
Cuyahoga County						
Middleburgh Hts. S.D.		Abram Crk	S-Sec. 2,000 PE	-	Same as City of Middleburgh Hts. above.	U.C. (Yes)
Baldwin Creek					" " " " " " "	U.C. (Yes)
Lorain County						
Sewer District #60 West River Subdiv.		W,Branch Rocky R.	S-Sec. 60 PE	1959	None	
Sewer District #60 West View Park Subdiv.		W,Branch Rocky R.	No public sewers.	-	Sewers & new treat. facils - secondary.	Rep.& G.Plan 3-1-67(Yes) Detail Plans 6-1-67(Yes) Construction 12/68
Medina County						
Sewer District #9 Hinckley Lake Estates		E,Branch Rocky R.	S-Sec.+D 100 PE	1961	None	
Sewer District #11 Village Homes Subdiv.		W,Branch Rocky R.	S-Sec.+D 123 PE	1966	None	

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
SANDUSKY RIVER BASIN

Entity Pop.	1965 Stream.	Receiving Treat.& Design	Type Sew.Syst.	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities						
Fremont	20,058	Sandusky R.	C-Sec.+D 128,500 PE	1949-66	None	Completed construction 1966 (Yes)
Tiffin	22,475	Sandusky R.	C - Pr.+D 25,000 PE	1956	Improvements - secondary treat.	Under construct. 4-15-67(Yes) Construction 7-15-68
Villages						
Attica	1,012	Honey Crk	Misused storm drains.	-	New facils incl. secondary treat.	Rep.& G.Plan 6-15-67(No IP) Detail Plans 6-15-68 Construction 12-15-69
Bloomville	862	Honey Crk	Misused storm drains.	-	New facils incl. secondary treat.	Rep.& G.Plan 8-15-67 (Yes) Detail Plans 6-15-68 Construction 12-15-69
Upper Sandusky	5,286	Sandusky R.	S-Sec.+D 7,000 PE	1956	Improvements - addtnl treat.facils.	Rep.& G.Plan 3-15-68(yes) Detail Plans 3-15-69 Construction 9-15-70
Sewer Districts						
Sandusky County						
Sewer District #1		Muskellunge Creek	No treat.	-	Sewers & connection to Fremont sew.syst.	Detail Plans 1-15-68 (Yes) Construction 1969
Seneca County						
Clinton Township		Gibson Creek	No treat.	-	Sewers & connection to Tiffin sew.syst.	Detail Plans 11-15-67 (No) Construction 1968

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
VERMILION RIVER BASIN

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
City						
Vermilion	7,723	Vermilion River	S - 2 Plts Pr. + D 4,000 PE 1,500 PE	1921 1957	New facils incl. secondary treat.	Under construct. 3/67 (Yes) Construction 3/69

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
TRIBUTARY TO LAKE ERIE

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities						
Amherst	8,617	Beaver Crk	S - Sec. 10,000 PE	'27,'57	Improvements - addtnl treat.facils.	Rep.& G.Plan 12-15-67 (Yes) Detail Plans 12-15-68 (Yes) Construction 6-15-70
Bellevue	8,846	Big Ditch Pipe Crk	No public sewers.	-	New facils incl. secondary treat.	Under constr. early 1967(No) Construction 9-1-69
Conneaut	14,951	Conneaut Creek	S-Int.+D 17,000 PE	1957	Improvements - secondary treat.	Rep.& G.Plan 3-15-67 (Yes) Detail Plans 1-15-68(No) *(1 Construction 10-15-69
Westlake	14,574	Porter Crk	No public sewers.	-	Connection to County Sew.Dist.System.	Depends on current litigation re financing (Cuyahoga County project).
Villages						
Green Springs	1,316	Trib's to Sand. Bay	S & C - Pr. 1,300 PE	1936	Improvements - secondary treat.	Detail Plans 7-15-67 (Yes) Construction 12-15-68
Madison	1,435	Big Creek	S - Sec. 1,500 PE	1929		
			S - Sec. 2,000 PE	1967	Completely new facils-secondary treatment.	Construction 6/67 (Yes)
Walbridge	2,847	Cedar Crk	S-Pr.+D 1,000 PE	1941	Complete sewer connect. to Toledo sewer system.	Under construction. To complete connection (Yes) 6-15-67

*(1) Water Pollution Control Board approved revised schedule - detail plans due 4-69

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
TRIBUTARY TO LAKE ERIE - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Sewer Districts						
Erie County						
Perkins-Margaretta S.D. Subdistrict B		Pipe Crk	No public sewers.	-	New treat.facils (secondary) or connection to City of Sandusky sew.syst.	Rep.& G.Plan early '67 (Yes) Detail Plans 8-1-68 Construction 12-15-69
Lake County						
Painesville S.D. #3 Villa Rio Subdiv.		Marsh Crk	S-Sec.+D 75 PE	1963	None	
Willoughby-Mentor S.D. French Hollow Estates #9		Trib.of Marsh Crk	S-Sec.+D 100 PE	1964	None	
Lucas County						
Metropolitan S.D. Fuller's Creekside Subdiv.		Shantee Creek	S-Sec.+D 1000 PE	1962	None	
Wood County						
Main Sewer Dist. #9 Sanitary S.D. #1 Indian Trails Estates		Cedar Crk	S-Sec.+D 260 PE	1963	None	

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
DIRECT TO LAKE ERIE

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities						
Ashtabula	25,036	L.Erie	S-Int.+D 55,000 PE	1955	Improvements - secondary treat.	Rep.& G.Plan 3-15-67 (Yes) Detail Plans 6-15-68 Construction 10-30-70
Avon Lake	11,992	L.Erie	C-Int.+D 16,590 PE	1961	Improvements - secondary treat.	Rep.& G.Plan early '67 (Yes)*(1) Detail Plans 2-15-68 Construction 1970
Cleveland	858,823 + 484,423 21 Trib.Munic's	L.Erie	S & C Easterly Sec. + D 1,230,000 PE	1938	Addtnl treat.facils.	See attached schedule - City of Cleveland.
		L.Erie	Westerly Prim. + D 360,000 PE	'22,'57	Addtnl treat.facils.	ditto
Euclid	66,742	L.Erie	S-Int.+D 100,000 PE	1960	Improvements - secondary treat.	Rep.& G.Plan 5-1-67 (No IP) *1 Detail Plans 6-1-68 Construction 6-30-70
Oregon	14,829	L.Erie	-	-	New facils incl. secondary treat.	Rep.& G.Plan approved (Yes) Detail Plans 7-30-68 Construction 12-30-69
					(Part trib.to Toledo;remainder no pub.sewers.)	
Sandusky	33,841	L.Erie	S & C Pr.+D 49,300 PE	1959	Improvements - secondary treat.	Rep.& G.Plan early '67 (Yes) Detail Plans 6-30-68 Construction 11-30-70

*(1) Pilot study underway

STATUS OF MUNICIPAL WASTE TREATMENT FACILITIES
DIRECT TO LAKE ERIE - Contd.

Entity	1965 Pop.	Receiving Stream	Type Sew.Syst. Treat.& Design	Date Built	Additional Requirements	Approved Schedule (Completion Dates)
Cities - contd.						
Willoughby(a)	34,525	L.Erie	S-Int.+D 33,800 PE	1961	Improvements - secondary treat.	Rep.& G.Plan 4-15-67 (No) Detail Plans 7-15-68 Construction 7-15-70
Villages						
Geneva-on-the-Lake	706	L.Erie	S-Pr.+D 5,000 PE	1928	Improvements - secondary treat.	Rep.& G.Plan 6-15-67 (Yes) Detail Plans 6-15-68 Construction 12-15-69
Harbor View	280	L.Erie	No public sewers.	-		To be tributary to Oregon's sew.syst. (See Oregon above.)
Sewer Districts						
Cuyahoga County Rocky River S.D. #6		L.Erie	S-Int.+D 160,000 PE	1962	Improvements - secondary treat.	*(1) Rep.& G.Plan early '67 (No IP) Detail Plans 6-15-67 (no) Construction 9-15-69
Erie County E.Erie Co.Sewer & Wat.Dist. Ruggles Beach-Mittiwanga		L.Erie	S-Pr.+D 1,300 PE	1921	Improvements - secondary treat.	Rep.& G.Plan 3-1-67 (Yes) Detail Plans 8-1-68 Construction 12-15-69
Lake County Madison S.D. #1		L.Erie	S-Int.+D 9,000 PE	'24,'62	Improvements - secondary treat.	Rep.& G.Plan 1-1-68 (No IP) Detail Plans 1-1-69 Construction 1-1-71
Willoughby-Mentor S.D.		L.Erie	S-Int.+D	1965	ditto	ditto (No IP)

(a) - Eastlake - 27,525 pop. - trib.to Willoughby sewerage system.

*(1) Pilot study re: secondary treatment underway

SOUTHERLY PLANT
CITY OF CLEVELAND, OHIO

EXHIBIT A

CONTRACT	Completion Date Detail Plans	Period of Construction Start	Period of Construction Completion	Est. Total Cost Incl. Engr. etc @ 15%
New Secondary Treatment Facilities	Jan. 1967 *(Yes)	Sept 1967	Dec. 1969	$5,756,000
Pre-Treatment Expansion	June 1968 **	Sept 1968	Dec. 1969	980,000
Service Bldg. Conversion	June 1968 **	Sept 1968	Dec. 1969	517,000
Post-Chlorination Facil.	June 1968 **	Sept 1968	Dec. 1969	400,000
Primary Digester Gas Mixing	June 1968	Sept 1968	Dec. 1969	575,000
Roads and Lighting	June 1968	Sept 1968	Dec. 1969	345,000
				$8,573,000

* Design Authorized
** Design to be Authorized Jan. 1967

Based on projects receiving at least Federal Grant Aid

EASTERLY PLANT
CITY OF CLEVELAND, OHIO

EXHIBIT B

CONTRACT	Completion Date Detail Plans	Period of Construction Start	Period of Construction Completion	Est. Total Cost Incl. Engr. etc @ 15%
New Primary Settling tanks & Enlargements	June 1967 *(Yes)	Sept 1967	Dec. 1969	$2,990,000
4 New Final Settling Tanks & Enlargements	June 1968 **	Sept 1968	Sept 1970	1,104,000
Aeration Tank Improv	June 1968 **	Sept 1968	Sept 1970	1,966,000
New Grease & Scum Handling & Disposal Facilities	June 1967 *(Yes)	Sept 1967	Dec. 1969	414,000
New Southerly Sludge Pump Facilities	June 1967 * (Yes)	Sept 1967	Dec. 1969	299,000
New Detritus Tanks & Comminutors	June 1968	Sept 1968	July 1970	1,035,000
Collinwood Interceptor & Overflow Revisions	June 1968	Sept 1968	July 1970	173,000
Miscel. Plant Improv.	June 1968	Sept 1968	July 1970	460,000
				$8,441,000

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* Design Authorized
** Design to be Authorized Jan. 1967

Based on project receiving at least Federal Grant Aid.

WESTERLY PLANT
CITY OF CLEVELAND, OHIO

EXHIBIT C

CONTRACT	Completion Date Detail Plans	Period of Construction Start	Period of Construction Completion	Est. Total Cost Incl. Engr. etc. 15%
Item 1 Site Work	June 1967 * (No)	Sept 1967	June 1968	$ 5,869,000
Item 2 Plant Work	June 1968 *	Sept 1968	Dec. 1970	8,651,000
Item 3 Lift Station	June 1969 *	Sept 1969	Dec. 1970	1,505,000
Item 4 Digester Facilities	June 1969 *	Sept 1969	Dec. 1970	728,000
Item 5 Sludge Disposal Facilities	June 1969 *	Sept 1969	Sept 1971	1,775,000
Item 6 Miscellaneous	June 1969 *	Sept 1969	Dec. 1971	202,000
				$18,731,000

* Design to be Authorized Feb. 1967

Based on projects receiving at least Federal Grant Aid

George H. Eagle

EXHIBIT D

WATER POLLUTION CONTROL BOARD

DATA RE CURRENT PROGRAM OF IMPROVEMENTS

DATE: January 5, 1967

NAME OF PERMITTEE: City of Cleveland

ADDRESS: 601 Lakeside Ave.
Cleveland, Ohio - 44114

SUBURBAN TRUNK SEWERS PROJECT

Name of Consulting Engineer: Consulting Engineer or Engineers will be retained after legislation authorizing employment of consulting engineers is passed by the Cleveland City Council. The original legislation that was prepared to go to City Council the early part of October 1966 was withheld so that the City could explore more carefully and fully the possibility of city forces doing some of the engineering work. This legislation will now go to the City Council for their consideration on January 9, 1967.

Completion Date of General Plan: Estimated to be Dec. 31, 1967.(no)

Completion Date of Detail Plans: Estimated to be Dec. 31, 196~~7~~8.

Financing Program: The total cost of the Suburban Trunk Sewer Project has been estimated at $20,500,000.

The financing of Engineering for General and Detail Plans including specifications, has already been provided for in the new three year Agreement on Sewerage Service Charges effective July 1, 1966 between Cleveland and the suburbs that it services.

The Cleveland Master Plan for water pollution abatement and control will study the financing of construction which is planned to start after July 1, 1969. However this will be contingent on an agreement being reached between Cleveland and the suburbs as to the financing of these trunk sewers which basically will serve to bring suburban sewage direct to the Cleveland plants.

Date of Start of Construction: After July 1, 1969

Date of Completion of Construction: Impossible to estimate at this time.

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
ASHTABULA RIVER BASIN

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Cabot Titania Corporation Titanium Dioxide Plant	Chemical Suspended solids	Settling basins	Additional facilities for reduction of solids	Completed 9-1-66
Cabot Titania Corporation Titanium Tetrachloride Unit	Chemical Suspended solids	Lagoons	Additional facilities for reduction of solids	Plans 1-67 Construction 6-1-67 (Yes)
Detrex Chemical Industries, Inc. Chlorinated Solvents Division	Chemical Hydrocarbons	Lagoons settling Neutraliz.	In-plant control of hydrocarbons	Completed 2-1-67(Yes) *(1)
Diamond Alkali Company Semi-Works	Chemical, Acids Suspended solids	Neutraliz. Chem. treat. settling incineration	Additional facilities and control for solids reduction	Completed 9-1-66 (Yes
The General Tire & Rubber Company, Chemical Division	Chemical solids	Chemical treatment settling	Additional facilities and control for solids	Completed 12-1-66 (Yes)
Olin Mathieson Chemical Corp. TDI Facility	Chemical solids	Lagoons	In-plant improvements for neutralization and solids	Completed 12-66(Yes) *(1)
Reactive Metals, Incorporated Metals Reduction Plant	Chemical, Acids Solids	Neutraliz. settling	Additional facilities for solids removal	General Plans 9-1-66 Detail Plan 6-1-67 (Yes)
Reactive Metals, Incorporated Sodium & Chlorine Plant	Chemical, Susp. Dissolved solids	Settling ponds	Additional in-plant controls for solids reduction	Construction 10-1-67 (Yes) Completed 12-67

*(1) Additional controlled facilities required by Water Pollution Control Board permit (U.C.)

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
BLACK RIVER BASIN

List of Complete Industrial Waste Plants

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Locke Manufacturing Company	Steel-Acid Iron	Neutraliz.	Discharge to municipal system. Exempt	Completed 7-1-66 (Yes)
Republic Steel Corporation Steel and Tubes Division	Steel-Acid Iron	Controlled discharge after settling	Reduction of acids	Plans 6-1-68 Construction 12-31-69
Ternstedt Division General Motors Corporation	Metal Finish.	Cyanide oxidation chrome reduction settling	Expanded treatment facilities under construction	Construction 11-15-67
U. S. Steel Corporation Tubular Operations	Steel-Blast Furn. Susp. solids	Clarification	Additional reduction of solids	Study report 6-1-67 IP (No) Construction 12-31-69

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CHAGRIN RIVER BASIN

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Chase Bag Company	Paper Mill	Filtration for removal of solids	Secondary treatment facilities	Plans 6-1-68 (Yes) Construction 12-31-69

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
CUYAHOGA RIVER BASIN

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
The Bailey Wall Paper Company	Organic	None	Company plans to move to new location on public sewer	7-1-67 (No) *(1)
The Cuyahoga Meat Company	Meat Packing	Septic tank	New complete treatment facilities	Plans 4-1-67 (Yes) Complete construction 6-1-68
Diamond Crystal Salt Company	Chemical	Settling	Additional reduction of chlorides	Plans 6-1-67 (No) *(2) Construction 1-1-68 (No)
E. I. duPont deNemours and Company, Incorporated Ind. and Biochemicals Dept.	Chemical, Acids, Metals	Zinc recovery Acid neutraliz.	Improvements to treat. and disposal facilities	Completed 8-1-66 (Yes)
Ferro Chemical Division of Ferro Corporation	Chemical Suspended solids	Clarification	Improvements to treat. facilities	Plans 10-1-66 Construction 4-1-67 (Yes)
Firestone Tire & Rubber Company Akron Plant	Solid, oils and organics	Some waste trib. to mun. sewers	Reduction of all critical constituents	Plans 1-1-68 (Yes) Construction 1-1-69
General Tire & Rubber Company Akron Plant	Solid, oils and organics	Some waste trib. to mun. sewers	Reduction of all critical constituents	Plans 1-1-68 (No) Construction 1-1-69
B. F. Goodrich Rubber Company Akron Plant	Solid, oils and organics	Some waste trib. to mun. sewers	Reduction of all critical constituents	Plans 1-1-68 (Yes) Construction 1-1-69

*(1) Plant to cease operation - 1968

*(2) Inplant recovery and deep well disposal understudy

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
CUYAHOGA RIVER BASIN - Contd.

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Goodyear Aerospace Corporation	Metal Finish.	Control facilities	Facilities for pretreatment & discharge to municipal sewers	Plans 6-1-67 (Yes) Construction 6-1-68
Goodyear Tire & Rubber Company Akron Plant	Solid, oils and organics	Some waste trib. to mun. sewers	Reduction of all critical constituents	Plans 1-1-68 (Yes) Construction 1-1-69
Harshaw Chemical Company	Metal Salts	In-plant control	Additional in-plant control of metals & fluorides. Settleable solids removal	Plans 7-1-67 (Yes) Construction 12-31-68
Jones & Laughlin Steel Corp.	Steel-Acid Iron	Controlled discharge	Removal or treatment of waste pickling acids	Plans 6-1-67 (Yes) *(1) Construction 8-1-67 (No)
Jones & Laughlin Steel, Corp.	Steel-Blast Furn. Suspended solids	Clarification	Improved reduction of solids	Plans 6-1-68 (Yes) Construction 12-31-69
Jones & Laughlin Steel, Corp.	Steel-Mill Scale Suspended solids	Clarification	Improved reduction of solids	Plans 6-1-68 (Yes) Construction 12-31-69
Larkis Asphalt Company, Inc.	Asphalt (Unclassified)	Lagoon	Improved reduction of suspended solids	Construction 7-1-66 (Yes)
Master Anodizers & Platers, Inc.	Metal Finish.	Chrome reduction	Improved reduction of metals and solids	Plans approved 1-67 (Yes) Construction 7-1-67 (Yes)

*(1) Construction 12-31-68

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
CUYAHOGA RIVER BASIN - Contd.

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Republic Steel Corporation Bolt & Nut Division	Steel-Acid Iron	Controlled discharge	Plating wastes to municipal sewers Removal or treatment of waste pickling liquors	Construction 12-31-68 Plans 6-1-68 (Yes) Construction 12-31-69
Cleveland District	Steel-Acid Iron	Controlled discharge	Removal or treatment of waste pickling liquors	Plans 6-1-68 (Yes) Construction 12-31-69
Cleveland District	Steel-Blast Furn. Suspended solids	Clarification	Improved reduction of suspended solids	Plans 6-1-68 (No) Construction 12-31-69
Cleveland District	Steel Mill Scale Suspended solids	Scale pits	Improved reduction of suspended solids	Plans 6-1-68 (No) Construction 12-31-69
Sonoco Products Company Ohio Division	Paper Mill	Aeration and clarification	Connect to County Sewer	Construction 1-30-69
The Standard Oil Company No. 1 Refinery	Oil Refinery	Oil separation and recovery	Refinery operations discontinued. Wastes from asphalt processing to be made tributary to Cleveland municipal sewers.	Construction 6-1-67 (Yes)
Sherwin Williams Linseed Oil Mill	Oily sludges	Filtration	Discharge of filtrate to Cleveland mun. sewers	
U. S. Steel Corporation Central Furnaces	Steel-Blast Furn. Suspended solids	Clarification	Additional reduction of suspended solids	Plans 6-1-68 (No) Construction 12-31-69
Central Furnaces	Blast Furnace (Sewage)	None	To municipal sewers. Exempt	Construction 12-8-66 (Yes)

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
CUYAHOGA RIVER BASIN - Contd.

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Cuyahoga Works	Steel-Acid Iron	Controlled discharge	Neutralization of pickling acids and removal of solids and metals	General plan 11-66 Detail plans 3-67(Yes) Construction 12-68
Cuyahoga Works	Steel-Mill Scale Suspended solids	Scale pits	Additional reduction of suspended solids and oil	General plans 11-66 Detail plns 3-67 (Yes) Construction 12-68 UC
Weather-Tite Company	Metal Finish	Aluminum removal	Neutralization and reduction of solids	Detail plans 10-66 (Yes) Construction 7-67 (Yes)

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
GRAND RIVER BASIN

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Diamond Alkali Company	Chemical, Susp. & dissolved solids, chromium	Settling, neutralization reduct. - controlled discharge	Reduction of chrome wastes Additional facilities for neutralization and solids reduction	Plans 3-1-67 (Yes) UC Construction 10-1-67 (No) Plans 6-1-67 (Yes) Construction 6-1-68 (Yes)
The Metal Craft Company	Metal Finish.	Controlled discharge	Neutralization and reduction of solids	Plans 4-1-67 (Yes) Construction 6-1-67 (No) UC
A. E. Staley Manufacturing Co.	Chemical Soy Bean Prod.	Recovery facils. and lagoon	Treatment by municipality when facilities available	12-68
UNIROYAL United States Rubber Co. Chemical Division Plant Area #4	Chemical	Chem. treat. and lagoon	Facilities being rebuilt following explosion. *(1) Evaluation of additional needs to follow.	
United States Rubber Company Chemical Division Plant Area #1	Chemical, Susp. & Dissolved solids	Screening, settling lagoons	Additional facilities for solids, oxygen demanding material and solids	General Plans 1-1-68 *(1) Detail plans 10-1-68 Construction 12-1-69

HURON RIVER BASIN

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (CompletionDates)
The Baltimore & Ohio Railroad Co.	Railroad Oil	Oil Separators	Additional facilities for removal of oil	Plans 7-1-67 (No) Construction 7-1-68
Clevite Corporation Harris Division, Milan Plant	Metal Finish.	Settling (lagoon)	Additional facilities for neutralization and reduction of metals and solids	Plans 7-1-67 (Yes) Construction 7-1-68 (UC)

*(1) Water Pollution Control Board revised schedule

General Plans	3-1-68 (Yes)
Detail Plans	10-1-68
Construction	12-1-69

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
MAUMEE RIVER BASIN

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Campbell Soup Company	Organic Soup Cannery Tomato Cannery	Trickling filters for soup production, land spray for tomato oper's	Additional reduction of solids and oxygen demand	Detail plans 1-68 (Yes) Construction 7-1-69
Central Foundry Division GMC, Defiance Plant	Steel Foundry	Settling lagoons	Additional solids reduction	Construction 7-1-67 (UC)
Clevite Corporation Harris Division Napoleon Plant	Metal Finishing	Settling and filtration	Additional facilities neutralization, reduction of metals and solids	Plans 7-1-67 (Yes) Construction 7-1-68
Edgerton Metal Products, Inc.	Inorganic Metal Finish.	Cyanide oxidation	Treatment of chrome wastes, neutralization, reduction of solids	Construction 7-1-67 (Yes)
Elite Plating Division Dynavest Corporation	Metal Finish.	None	Reduction of metals and cyanide, neutralization	Plans 7-1-67 (No) Construction 7-1-68
Hayes Industries, Inc. Decorative Division	Inorganic, Metal plating	Acid neutralis. settling	Additional facilities for improved reduction of solids and neutralization	Complete 7-1-66 (Yes)
Interlake Steel Corporation	Steel Blast Furnace	Clarification	Additional reduction of solids	Plans 5-1-68 (No IP) Construction 8-1-69

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
MAUMEE RIVER BASIN - Contd.

Entity	Type of Wastes	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Johns-Manville Fiber Glass, Incorporated, Plant #3	Phenolic	Reuse system Chemical Treat.	Facilities for closed recycle system under construction	Completion 8-1-67 (Yes)
Johns-Manville Fiber Glass, Incorporated, Waterville Plt.	Organic Phenolic	Swale area, soil infilt.	Additional facilities for complete treatment	Completed 12-1-66(Yes)
Libby, McNeill & Libby	Organic Tomato process.	Land spray disposal	Additional facilities for treatment of peak loads	Plans 6-1-67 (No IP) Construction 8-1-67 (No)
National Refining Company Division of Ashland Oil & Refining Company	Oil Refinery	API separator	Additional facilities for oil, solids and oxygen demand reduction under construction	Plans 9-1-66 Construction 6-1-67 (Yes
Pepsi-Cola Bottling Company	Food Process. (Misc.)	Complete treatment	Additional facilities for reduction of oxygen demand	Plans 3-1-67 *(1) Construction 1-1-68
Republic Creosoting Company, Division of Reilly Tar & Chemical Corporation	Phenolic Wood Preserving	Separator and straw filters	Reduction of phenolics and oil	Plans 1-1-68 (No IP) Construction 1-1-69
Rusco Division Rusco Industries, Incorporated	Inorganic Metal Finish.	Acid neutraliz. settling	Neutralization and solids reduction	Plans 8-1-67 (Yes) Construction 8-1-68

*(1) Area annexed to city; municipal sewers to be made available

STATUS OF INDUSTRIAL W. STE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
MAUMEE RIVER BASIN - Contd.

Entity	Type of Wastes	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
S-K Wayne Tool Company	Inorganic Metal Finish.	In-plant control monitored disch.	Neutralization and metals reduction	Plans 3-1-67 **(Yes)** Construction 1-1-68 **(No)**
Vistron Corporation (formerly Sohio Chem. Co.)	Chemical	Lagoon	Additional reduction of nitrogen compounds	1-1-68In-plant controls 1-1- **(Yes)** Research studies under
Sohio Chemical Company	Organics Petro chemicals	Chemical, lagoon, incineration & biological treatment	Additional reduction of nitrogen compounds and oxygen demand	Plans 1-1-68 **(Yes)** Construction 1-1-69
The Standard Oil Company	Oil Refinery	API separator, air flotation facils	Aerated lagoon for biological treatment	Completed 2-1-67 **(Yes)**
Walter & Sons, Incorporated	Organic	Septic tank, sand filter	Process change Evaluate existing facil. for present operations	Evaluation 8-1-67 ***(1)**
The Weatherhead Company Ohio Division	Inorganic Metal Plating	Chemical, Cyanide oxid., sec.treat. of sewage	Additional reduction of metals and solids	Plans 6-1-67 **(Yes)** Construction 9-1-68 **UC**

***(1) Area annexed to city; municipal sewers to be provided**

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
OTTAWA RIVER (TENMILE CRK) BASIN

Entity	Type of Wastes	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Dana Corporation Toledo Division	Oil Treatment (Unclass.)	Chemical treatment & reuse	Improvements in facilities and operation	Completed 12-1-66 (Yes)

PORTAGE RIVER BASIN

Entity	Type of Wastes	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
The Seneca Wire and Manufacturing Company	Steel-Acid Iron	Neutraliz., settling controlled discharge	Additional facilities for metals and solids	Plans 1-1-68 (No) Construction 1-1-69
Swift & Company	Soybean Mill Chemical	Grease separation	Facilities for reduction of oil, color and oxygen demand. Anticipate connection to mun. sewers	Construction 6-1-67 (No)

ROCKY RIVER BASIN

Entity	Type of Wastes	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Astoria Plating Corporation	Metal Finish.	Cyanide oxiation, chrome reduction	Additional facilities for reduction of metals and cyanide	Plans 4-1-67 (Yes) Construction 1-1-68 (No)

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
LAKE ERIE DRAINAGE AREA IN OHIO
SANDUSKY RIVER BASIN

Entity	Type of Wastes	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Northern Ohio Sugar Company	Beet Sugar	Holding lagoons controlled discharge	Additional reduction of oxygen demand	Plans 12-31-68 Construction 12-31-69
The Pioneer Rubber Company Plant No. 2	Rubber-Alcohol	None	Facilities for reduction of oxygen demand	Anticipate connection to proposed municipal sewerage

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STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
TRIBUTARY TO LAKE ERIE

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Bechtel-McLaughlin, Incorporated	Metal Finishing	Cyanide oxidation	Facilities for neutralization, chrome and solids reduction	Plans 2-1-67 (Yes) Construction 2-1-68 *(1)
Doehler-Jarvis Division National Lead Company Toledo Plant #2	Metal Finishing	In-plant controls & recovery	Additional facilities for reduction of metals, solids and cyanide	Plans 6-1-67 (Yes) Construction 6-1-68
Central Soya Company	Oils and organics	Lagoons	Additional facilities for reduction of oil	Plans 6-1-67(Yes) Construction 6-1-68
Cleveland Metal Cleaning Company	Acids, oil and solids	None	Facilities for neutraliz. and oil and solids removal	Plans 8-1-67 (Yes) Construction 7-1-68
Donn Products, Incorporated	Metal Finishing	Neutralis. Lagoon	Additional facilities for treatment of chromium waste	Plans 7-1-67 (Yes) Construction 1-1-68 (Yes)
General Electric Company Bellevue Lamp Plant #242	Sewage only	Septic tank	To be made tributary to municipal system	Construction 9-1-69
Hirzel Canning Company	Tomato-Beet Cannery	Land spray	Additional facilities for more positive control of wastes	Plans (Yes) Construction 8-1-67 U.C.
The Lake Erie Canning Company	Cannery Tomato, Kraut, Cherry	Lágoon	Additional facilities for reduction of oxygen demand	Plans 3-1-67 (Yes) Construction 8-1-67 (Yes

*(1) Anticipate connection to public sewers

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES TRIBUTARY TO LAKE ERIE
Contd.

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
Libbey-Owens-Ford Glass Co. East Toledo Plant	Glass Mfg.	Lagoons	Additional facilities for solids reduction	Plans 10-1-67 (No) Construction 1-1-69
Natl. Aeron. & Space Admin. Plum Brook Station (Research Center)	Sewage only	Primary	Secondary treatment	Plans ? Construction 12-1-67 (Yes)
Norfolk & Western Railroad Bellevue Yards	Oils	None	Facilities for removal of oils and solids	Plans 6-1-67 (Yes) Construction 6-1-68
The Standard Oil Company Toledo Refinery	Oils	Oil separators lagoons	Additional facilities for reduction of oil, solids, phenols and oxygen demand	Plans 1-1-68 (Yes) Construction 12-31-69
Toledo Scale, Division of Toledo Scale Corporation	Metal Finishing	Settling and controlled discharge	Facilities for reduction of metals, solids and oil	Plans 7-1-67 (Yes) Construction 7-1-68
True Temper Corporation	Metal Finishing	Chrome reduction, cyanide oxidation	Additional facilities for reduction of solids and oil	Plans 5-66 Construction 6-1-67 (Yes)

STATUS OF INDUSTRIAL WASTE TREATMENT FACILITIES
DIRECT TO LAKE ERIE

Entity	Type of Waste	Treatment Provided	Additional Requirements	Approved Schedule (Completion Dates)
The Cleveland Electric Illum. Co.				
Ashtabula Plant	Suspended solids	Lagoons	Additional facilities for reduction of solids	Plans 12-67 (Yes) Construction 12-68
Avon Plant	Suspended solids	Lagoons	Additional facilities for reduction of solids	Plans 7-1-67 (Yes) Construction 7-1-68
Lakeshore Plant	Suspended solids	Lagoons	Additional facilities for reduction of solids	Plans 12-67 (Yes) Construction 10-68
Eastlake Generating Station	Suspended solids	Lagoons	Additional facilities for reduction of solids	Plans 7-67 (Yes) Construction 4-68
IRC Fibers Division Midland-Ross Corporation	Suspended solids Zinc, organics	Lagoons	Facilities for neutraliz. and reduction of zinc and solids	Plans 2-1-67 (Yes) Construction 1-1-69
The Lubrizol Corporation	Chemical	Chemical & Biological Oil Removal	Additional facilities for reduction of oxygen demand	Plans 4-1-67 (Yes) Construction 12-1-67 (Yes)
TRW, Incorporated	Metal Finishing	Chemical & settling tanks	Additional facilities for neutralization and reduction of metals & solids	Plans 12-1-66 (Yes) Construction 1-1-69
United States Gypsum Company	Paper Mill	Clarification & in-plt. reuse	Facilities for complete treatment	Plans 9-1-68 (Yes) Construction 12-31-69
United States Rubber Company	Chemical	Wastes treated in Erie Ordinance complete facilities		Connected 7-15-66

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APPENDIX II

1. Water Quality Criteria For Lake Erie and the Interstate Waters Thereof
2. Water Quality Standards for Ashtabula River, Conneaut Creek, and Turkey Creek
3. Water Quality Standards for the North Central Ohio Tributaries of Lake Erie
4. Conclusions and Recommendations for the Rocky River, Cuyahoga River, Chagrin River, Grand River and Tributaries
5. Water Quality Standards Adopted for the Maumee, Tiffin, St. Joseph, and St. Marys River Basins.
6. Removal of Phosphates from Waste Waters
7. Sanitary Sewer Joints and Manholes

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WATER POLLUTION CONTROL BOARD
DEPARTMENT OF HEALTH
COLUMBUS, OHIO

WATER QUALITY CRITERIA ADOPTED BY THE BOARD APRIL 11, 1967, FOR LAKE ERIE AND THE INTERSTATE WATERS THEREOF

The Ohio Water Pollution Control Board hereby adopts the following water quality criteria for Lake Erie and the interstate waters thereof which may affect the State of Michigan, the Commonwealth of Pennsylvania, the State of New York, and the Province of Ontario of the Dominion of Canada.

Water Quality - Conditions and Criteria

All Waters condition All the waters considered herein shall meet the following all times:

(1) shall be free from substances attributable to municipal, trial, or other discharges that will settle to form escent or otherwise objectionable sludge deposits;

(2) They shall be free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial, or other discharges in amounts sufficient to be unsightly or deleterious;

(3) They shall be free from materials attributable to municipal, industrial, or other discharges producing color, odor, or other conditions in such degree as to create a nuisance; and,

(4) They shall be free from substances attributable to municipal, industrial, or other discharges in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.

Lake Erie Water Quality Criteria for Various Uses are: (1) the Stream-Water Quality Criteria for Various Uses adopted by the Ohio Water Pollution Control Board on June 14, 1966, copy attached, which shall apply as a minimum to all Lake Erie waters in Ohio, and (2) the existing lake water quality which shall apply where better than the criteria for streams adopted by the Board. The existing lake water quality shall be as reported by the Federal Water Pollution Control Administration in the chapter on Water Quality in report "Program for Water Pollution Control - Lake Erie - 1967."

Lake Erie outside the established harbors at Lorain, Cleveland, and Ashtabula shall meet the Lake Erie water quality criteria for all uses.

The Lorain, Cleveland, and Ashtabula harbor waters in Lake Erie shall meet the Lake Erie water quality criteria for industrial water supply and aquatic life (A).

Implementation and Enforcement Plan

The Ohio Water Pollution Control Board, under the provisions of Sections 6111.01 to 6111.08, 6111.31 to 6111.38, and 6111.99, Ohio Revised Code, has authority to control, prevent, and abate pollution in the waters of this state. In accordance with such authority, the Board hereby adopts the following program and requirements for the prevention, control, and abatement of new or existing pollution of the waters of Lake Erie:

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(1) The "Recommendations and Conclusions - August 12, 1965" agreed upon by conferees from Michigan, Indiana, Ohio, Pennsylvania, New York, and the U.S. Public Health Service following conference under Section 8 of the Federal Water Pollution Control Act in the matter of pollution of the interstate and Ohio intrastate waters of Lake Erie and its tributaries held in Cleveland, Ohio, August 3-6, 1965, and in Buffalo, New York, August 10-12, 1965, and "Report of the Lake Erie Enforcement Conference Technical Committees - March, 1967" are included as a part of this program insofar as applicable to Lake Erie waters in Ohio (see attached copies);

(2) All plans and proposals for abatement or correction of pollution will be approved by the Ohio Department of Health as required by law and such approvals shall constitute approval by the Board;

(3) All sewage will be given secondary treatment (biochemical oxidation), and the facilities to provide such treatment will be constructed and placed in operation without delay, and in no instance later than the dates specified in the attached lists;

(4) All effluents will be satisfactorily disinfected to meet the criteria for Lake Erie water uses and the facilities to provide such disinfection will be installed without delay;

(5) All industrial wastes will be adequately treated to meet the Lake Erie water quality conditions and criteria and the facilities to provide such treatment will be constructed and placed in operation without delay, and in no instance later than the dates specified in the attached lists;

(6) Local programs will be initiated to control and reduce pollution resulting from (a) bypassing, (b) spillages, and (c) discharges resulting from construction or breakdowns;

(7) Necessary studies will be made and, where feasible, plans and construction programs will be developed as rapidly as possible for reducing pollution from combined sewer overflows;

(8) Where necessary to improve water quality and to reduce algal growths in Lake Erie, supplementary treatment of wastewaters will be provided to the fullest extent consistent with research and technological advances;

(9) Where necessary to protect recreational areas of Lake Erie, studies will be made by the responsible agencies, and plans and construction programs will be developed as rapidly as possible for improvements such as (a) elimination, treatment, or diversion of combined and storm sewer discharges from beaches and other recreational areas, (b) diversion of all effluent discharges, both sewage and industrial wastes, from areas where they may adversely affect recreational waters, and (c) elimination of the physical entrapment of storm water, marsh drainage, debris, and other pollutants at beach areas;

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(10) The Lake Erie water quality monitoring program will be expanded as outlined in the attached report to adequately provide assurances of compliance with these criteria.

Furthermore, the Board and the Ohio Department of Health will:

(1) Encourage and assist other agencies such as the Ohio Water Commission and the Soil Conservation Service, U.S. Department of Agriculture, in the implementation of effective soil erosion control programs, and programs for the reduction of the run-off of phosphorous, nitrogen compounds, and pesticides;

(2) Encourage the enactment of state legislation prohibiting the discharge of untreated wastewater from pleasure craft to the Lake Erie waters in Ohio, and requiring adequate waste disposal facilities at marinas along Lake Erie; and,

(3) Seek adequate legislation prohibiting the open dumping of garbage, trash, and other deleterious refuse along the shores of Lake Erie.

Enforcement of these requirements will be carried out by means of the respective permits issued to municipalities, counties, industries, and other entities discharging to the Lake Erie waters of Ohio considered herein, and failure to comply with the permit conditions will result in legal action in accordance with the provisions of laws.

WATER POLLUTION CONTROL BOARD
DEPARTMENT OF HEALTH
COLUMBUS, OHIO

WATER QUALITY STANDARDS ADOPTED BY THE BOARD JUNE 13, 1967, FOR ASHTABULA RIVER, CONNEAUT CREEK, AND TURKEY CREEK

The Ohio Water Pollution Control Board hereby adopts water quality standards for the following interstate waters:

(1) Ashtabula River;

(2) Conneaut Creek; and,

(3) Turkey Creek.

All of these streams originate in Pennsylvania and flow northwesterly through Ohio to Lake Erie.

Water Quality - Conditions and Criteria

All Waters. All waters considered herein shall meet the following conditions at all times:

(1) Free from substances attributable to municipal, industrial, or other discharges, or agricultural practices that will settle to form putrescent or otherwise objectionable sludge deposits;

(2) Free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial, or other discharges, or agricultural practices in amounts sufficient to be unsightly or deleterious;

(3) Free from materials attributable to municipal, industrial, or other discharges, or agricultural practices producing color, odor, or other conditions in such degree as to create a nuisance;

(4) Free from substances attributable to municipal, industrial, or other discharges, or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.

Stream-Water Quality Criteria for Various Uses adopted by the Ohio Water Pollution Control Board on June 14, 1966, shall apply to all waters under consideration herein and, in addition, the following criteria for cold-water fisheries shall apply:

(1) Dissolved Oxygen - minimum 6.0 mg/l.

(2) Temperature - maximum 70 deg. F.

(3) pH - not less than 6.5 nor greater than 8.5 at any time.

Conneaut Creek upstream from the New York Central Railroad Bridge in Conneaut and Turkey Creek shall meet the criteria for all uses including cold-water fisheries.

Conneaut Creek downstream from the New York Central Railroad Bridge in Conneaut and the Ashtabula River above the ship channel (approximately two miles above the mouth of the river) shall meet the criteria for all uses except cold-water fisheries.

Ashtabula River ship channel section, which extends approximately two miles upstream from the mouth of the river, shall meet the criteria for industrial water supply and aquatic life (A).

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Implementation and Enforcement Plan

The Ohio Water Pollution Control Board, under the provisions of Sections 6111.01 to 6111.03, 6111.31 to 6111.38, and 6111.99, Ohio Revised Code, has authority to control, prevent, and abate pollution in the waters of this state. In accordance with such authority, the Board hereby adopts the following program and requirements for the prevention, control, and abatement of new or existing pollution of the waters of the state considered herein:

(1) The design or critical flow defined as the minimum annual seven consecutive day warm weather flow which is exceeded in 80% of the years will be used in applying the stream-water quality criteria;

(2) All plans and proposals for abatement or correction of pollution will be approved by the Ohio Department of Health as required by law and such approvals shall constitute approval by the Board;

(3) All sewage and organic industrial wastes will be given secondary treatment (biochemical oxidation) prior to discharge to the waters under consideration (none existing at present);

(4) All sewage effluents will be satisfactorily disinfected, prior to discharge, to meet the criteria for downstream water uses (none existing at present);

(5) All other pollution constituents will be adequately treated and/or controlled to meet the water quality conditions and criteria, and the facilities to provide such treatment will be constructed and placed in operation without delay, and in no instance later than the dates specified in the attached schedules;

(6) Local programs will be initiated to control and reduce pollution resulting from (a) bypassing, (b) spillages, and (c) discharges resulting from construction or breakdowns:

(7) Necessary studies will be made and, where feasible, plans and construction programs will be developed as rapidly as possible for reducing pollution from existing combined sewer overflows and inadequate sewage collection systems:

(8) Where necessary to improve water quality and to reduce algal growths, supplementary treatment of wastewaters will be provided to the fullest extent consistent with current research and technological advances:

(9) Ohio's stream-water quality monitoring program will be expanded as outlined in the attached report to adequately provide assurances of compliance with these standards.

Furthermore, the Board and the Ohio Department of Health will encourage and assist other agencies such as the Ohio Water Commission and the Soil Conservation Service, U.S. Department of Agriculture, in the implementation of effective soil erosion control programs, and programs for the reduction of the run-off of phosphorous, nitrogen compounds, and pesticides.

Enforcement of these requirements will be carried out by means of the respective permits issued to municipalities, counties, industries, and other entities discharging to the waters considered herein, and failure to comply with the permit conditions will result in legal action in accordance with the provisions of law.

WATER POLLUTION CONTROL BOARD
DEPARTMENT OF HEALTH
COLUMBUS, OHIO

WATER QUALITY STANDARDS FOR THE NORTH CENTRAL OHIO TRIBUTARIES OF LAKE ERIE

ADOPTED BY THE BOARD ON NOVEMBER 14, 1967

The Ohio Water Pollution Control Board hereby adopts water quality standards for the following intrastate waters:

(1) The Portage River;

(2) The Sandusky River;

(3) The Huron River;

(4) The Vermilion River;

(5) The Black River; and

(6) All other tributaries of Lake Erie from Maumee Bay on the west to the Black River on the east.

The Amended Stream-Water Quality for Various Uses and the Minimum Conditions Applicable to All Waters adopted by the Board on October 10, 1967, shall apply to all waters under consideration herein, except for the following two variances for the Portage and Sandusky Rivers:

(1) Dissolved Solids: (For Public Water Supply)
Not to exceed 750 mg/l as a monthly average value, nor exceed 1000 mg/l at any time;

(2) pH: (For Industrial Water Supply and for Aquatic Life)
Not less than 6.5 nor greater than 9.0 at any time.

In addition, the following criteria for cold-water fisheries shall apply:

(1) Dissolved Oxygen: Minimum of 6 mg/l at any time;

(2) Temperature: Maximum 70 deg. F. at any time.

All Waters shall meet the minimum conditions and the stream-water criteria for all applicable uses. The recommendations contained in the Northwest Ohio Water Development Plan, January 1, 1967, shall serve as a guide in determining existing and future water uses.

(8) The sustained stream flow plan proposed in the Northwest Ohio Water Development Plan, January 1, 1967, and adopted by the Ohio Water Commission, is hereby made a part of this program and the Board recognizes that the implementation of this plan will be necessary to fully meet the water quality conditions and criteria; and

(9) The stream-water quality monitoring program will be expanded as recommended in the Northwest Ohio Water Development Plan, January 1, 1967, to adequately provide assurances of compliance with these standards.

Furthermore, the Board and the Ohio Department of Health will encourage and assist other agencies such as the Ohio Water Commission and the Soil Conservation Service, U.S. Department of Agriculture, in the implementation of effective soil erosion control programs, and programs for the reduction of the run-off of phosphorous, nitrogen compounds, and pesticides.

Enforcement of these requirements will be carried out by means of the respective permits issued to municipalities, counties, industries, and other entities discharging to the waters considered herein, and failure to comply with the permit conditions will result in legal action in accordance with the provisions of law.

SCHEDULES OF CORRECTIVE MEASURES FOR NORTH CENTRAL OHIO TRIBUTARIES TO LAKE ERIE

Corrective measures for the abatement of water pollution from discharges of sewage and industrial wastes will be provided for the following discharges according to the indicated time schedules.

Wastes from Municipalities, Etc.

Disinfection

All sewage discharges to meet downstream water uses will be adequately disinfected and the facilities for disinfection will be installed without delay and placed in operation no later than December 1, 1968.

Secondary Treatment

1. New secondary treatment (biochemical oxidation) plants where no facilities are now provided or to replace existing facilities will be provided by the following entities according to the indicated time schedules:

Entity	Completion Dates Report and Gen. Plan	Det. Plans & Financing	Construction
Attica	In prepar.	6-15-68	12-15-69
Avon*	Approved	6-15-68	12-15-69
Bellevue	Approved	Approved	9-16-69
Bloomville	Completed	6-15-68	12-15-69
Elmore	Approved	12-15-67	12-15-69
Gibsonburg	3-15-68	6-15-69	6-15-70
Green Springs (replaces Imhoff tank plant)	Approved	7-15-67	12-15-68
Pemberville	6-15-67	12-15-68	12-15-69
Tiffin		Approved	12-15-68
Woodville (to be trib. to Toledo Sew.Syst.)	8-15-67	8-15-68	12-15-69
Sandusky Co. S.D. #1			
Ballville Area		1-15-68	12-15-69
Prairie Run Area		Approved	12-15-68
Seneca County, Clinton Twp. (Melmore St. Area - to be trib.to Tiffin Sew.Syst.)		11-15-67	12-15-68

* - Only subdivision in village served by extended aeration plant.

2. New secondary treatment facilities which will be in addition to existing facilities will be provided by the following communities according to the indicated time schedules:

	Completion Dates		
Municipality	Report and Gen. Plan	Det. Plans & Financing	Construction
Huron	Approved	6-15-68	11-15-70
Lorain	Approved	6-29-68	12-15-70
Oak Harbor	8-15-67	8-15-68	12-15-69
Port Clinton	Approved	12-12-67	12-15-69

3. Enlargements of existing plants of the following communities having secondary treatment facilities will be provided according to the indicated time schedules:

	Completion Dates		
Municipality	Report and Gen. Plan	Det. Plans & Financing	Construction
Norwalk		Approved	12-15-68
Upper Sandusky	3-15-68	3-15-69	7-15-70
Vermilion			6-1-69 (Under constr.)

4. New or improved treatment facilities completed and placed in operation during 1967 and now adequate:

Fremont

LaGrange

Industrial Wastes

Additions or improvements to the facilities for treatment of industrial wastes from the following establishments so that adequate treatment or control is provided will be made in accordance with the indicated time schedules:

Name of Industry	Completion Dates Detail Plans	 Construction
Baltimore & Ohio Railroad Co. Willard	1-1-68	7-1-68
Bechtel & McLaughlin, Inc. Erie Co.-Perkins Twp.	Approved	12-31-67
Clevite Corporation Harris Division Erie Co.-Milan Twp.	Submitted	7-1-68
General Electric Company Bellevue Lamp Plant #242 Bellevue	To be trib.to Bellevue Sew.Syst.	
Hirzel Canning Company Wood Co.-Ross Twp.	5-1-68	8-1-68
Muskalonge View Dairy Sandusky Co.-Sandusky Twp.	3-1-68	1-1-69
Norfolk & Western Railway Co. Bellevue	3-1-68	1-1-69
Pioneer Rubber Co. Attica	To be trib. to Attica Sew.Syst. by 12-31-69.	
Pittsburgh Plate Glass Co. Richland Co.-Sandusky Twp.	5-1-68	5-1-69
Swift & Company Hancock Co.-Washington Twp.	6-1-68	6-1-69
Ternstedt Div., G.M.C. Elyria	Approved	6-1-68
U. S. Steel Corp.-Tubular Opns. Blast Furnace - Coke Plant Sewer Lorain	7-1-68	12-31-69
In addition - Central Soya Huron Co.-Lyme Twp.	Has completed and placed adequate disposal facilities in operation.	

LETTER OF SUBMITTAL

May 1, 1968

To: Ohio Water Pollution Control Board
450 East Town Street
Columbus, Ohio 43215

Gentlemen:

Submitted, herewith, is the report and recommendations of the engineering staff of the Ohio Department of Health on water quality and uses for the following intrastate waters:

1. The Rocky River and its tributaries.
2. The Cuyahoga River and its tributaries.
3. The Chagrin River and its tributaries.
4. The Grand River and its tributaries.

This report is prepared for presentation at the public hearing in Cleveland on May 22, 1968, which is being held by the Ohio Water Pollution Control Board under the provisions of 6111.03 (A) of the Ohio Revised Code.

You will note detail plans and schedules for compliance are not included in this report. Such plans and schedules will be submitted to the Board later after the stream-water quality criteria and uses are established. The Board will recall that water quality standards for Lake Erie, into which the streams under consideration discharge, were adopted on April 11, 1967.

The engineering staff wishes to acknowledge and thank the Federal Water Pollution Control Administration and the Water Quality Branch, Geological Survey, U.S. Department of Interior; the Ohio Department of Natural Resources, Divisions of Water and Wildlife; the Lake Erie Watershed Conservation Foundation; and, the Cuyahoga River Basin Water Quality Committee for their assistance.

Respectfully submitted,

George H Eagle

George H. Eagle
Chief Engineer

CONCLUSIONS AND RECOMMENDATIONS

1. The streams of the Rocky, Cuyahoga, Chagrin and Grand River basins drain a triangular shaped area in northeastern Ohio of roughly 2,180 square miles. Most of the metropolitan developments of Akron and Cleveland are included in the western portion of the area. All of the streams under consideration drain to Lake Erie.

   The population of the four drainage basins is nearly 2,200,000 people, 80% of which reside in the Cuyahoga River basin. The principal cities are Cleveland and suburban communities, Akron and suburban communities, Painesville, Chardon, Ravenna, Kent, Medina and Berea. The areas of rapid growth in the future are expected to be in the corridor between Akron and Cleveland and those portions of Medina, Portage and Geauga Counties nearest to these two cities.

   The major industrial developments are centered in the Cleveland-Akron portion of the Cuyahoga River basin and they include steel, rubber, chemical and metal fabricating industries. Basic chemicals is the major industry in the Grand River basin and this is near the mouth of the river. Only minor industrial developments are located in the Rocky and Chagrin River basins.

2. Two cities, Medina and Berea, obtain their water supplies from upstream branches of the Rocky River; Akron and the area supplied by it obtains water supply from the upper Cuyahoga River; Willoughby uses the Chagrin River; and, the City of Geneva and the Village of

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CHAIRMAN STEIN: Very good, Mr. Eagle.

This is really a comprehensive report. Just for some of these people sitting up here in the front row, I would like to commend this report here, and I see we have a complete list of municipal and industrial sources in this, and I am very happy with this report.

MR. EAGLE: Thank you.

CHAIRMAN STEIN: Any questions?

Again, I think this is the only device by which we can get this going. If you followed the pollution control programs in the States and in the cities, I think we, in listening to all these reports, are really moving along. We have a law, for better or worse, that gives us a device for State-Federal relations. We are trying to make it work, and I do think it is working and working rather well. At least it is contemplated by the people who wrote the law, and that is about all we can do, and I think we have programs moving forth rather consistently in the five Lake Erie States.

I think we have rather complete reporting with enough specificity so that all the interested people can see what is happening, and I think we are going ahead. Of course, we are spotlighting these problems as we are going along and will take them up.

I finally found that phosphate letter you had

Jefferson obtain their water supplies from the Grand River. The total public water supply usage is less than 70 MGD.

By far the greatest water usage is for industrial and power generating purposes. In the Akron area, this amounts to about 185 MGD; in the Cleveland area about 120 MGD; in the Willoughby area about 2MGD; and, in the Painesville area about 2.5 MGD.

Fishing, boating, wading, and in a few places swimming occur in each of the basins. Several stretches of the Rocky, Cuyahoga and Chagrin Rivers and their tributaries are within the Cleveland Metropolitan Park district and other park jurisdictions. The lower Cuyahoga River from Harvard Avenue to Lake Erie is used primarily for navigation and industrial water supply.

3. The principal pollution problems are dissolved solids, oxygen-consuming materials, bacteria, nutrients, color and floating debris and oil. The highly critical areas are in the Cuyahoga River below Akron and below the Cleveland Southerly Sewage Treatment Plant, and in the Grand River through the cities of Painesville and Fairport.

4. While good secondary wastewater treatment plants have been constructed or are in the process of being constructed, for many of the municipalities and sewered areas in the river basins under consideration, there are many overloaded facilities, unsewered areas, and combined sewer problems that remain to be taken care of. Similarily, the industrial wastes pollution loads have not been adequately reduced in all instances to meet recommended water quality criteria and uses. Much is yet to be accomplished in this area. Careful and comprehensive

management of the water resources of the four basins, and particularly the Cuyahoga River basin, is going to be absolutely necessary in order to attain the water quality goals recommended herein.

5. The minimum conditions applicable to all waters and the criteria of stream-water quality for various uses adopted by the Ohio Water Pollution Control Board on October 10, 1967 (see Appendix C) are proposed for all the waters under consideration except as noted in Paragraph 6. In addition, the following criteria for higher uses in certain streams stretches are proposed:

   (a) Cold Water Fisheries in the Chagrin River above Chagrin Falls, and the Aurora and the East Branches of the Chagrin River.

   Minimum dissolved oxygen concentration - 6.0 mg/l

   Maximum water temperature - 70°F.

   pH - not less than 6.5 nor greater than 8.5 at anytime.

   (b) Partial Body Contact (wading and boating) in the several stream stretches and reservoirs in the public park and recreational areas. This would be applicable, at this time, to the Rocky River below Berea; a section of the Cuyahoga River and its tributaries between Akron and Tinkers Creek; and, the Chagrin River below Gates Mills.

   Bacteria: coliform group not to exceed 5,000 per 100 ml.

as a monthly average value (either MPN or MF count) nor exceed this number in more than 20 percent of the samples examined during any month; nor exceed 20,000 per 100 ml in more than five percent of such samples. (This is a proposed tentative criteria subject to the resolution of the fecal coliform criteria by health authorities.)

6. The stream-water quality for the specific sections listed below should meet the minimum conditions, and the criteria for uses as follows:

   (a) The Cuyahoga River from the Akron Wastewater Treatment Plant to State Highway No. 17 bridge, should meet Aquatic Life B criteria at all times, and Partial Body Contact criteria where applicable, and, in addition, should meet Aquatic Life A criteria by not later than January 1, 1975, (see requirements in Paragraph 7);

   (b) The Cuyahoga River from State Highway No. 17 bridge to the U.S. Coast Guard Station, should meet Industrial Water Supply criteria by not later than January 1, 1971, and, in addition, should meet Aquatic Life B criteria by not later than January 1, 1975, (see requirements in Paragraph 7);

   (c) The Grand River from U.S. Hignway No. 20 bridge to the U.S. Coast Guard Station, should meet Aquatic Life B criteria by not later than January 1, 1971, and, in addition, should meet Aquatic Life A criteria by not later than January 1, 1975; and

(d) All other waters in the Rocky, Cuyahoga, Chagrin and Grand River basins, should meet the criteria for all applicable uses, including those for Cold Water Fisheries and Partial Body Contact in the stream stretches and reservoirs specified in 5.

To meet the minimum conditions and the criteria for the recommended uses will require: (1) efficient secondary treatment of all organic wastes; (2) further treatment (tertiary or advanced) in many instances where stream characteristics and conditions are critical by reason of low flows, seiches, uses and other influencing factors; (3) a high degree of treatment and/or control of other pollutants; (4) continuous disinfection of effluents for protection of public water supply, recreation and partial body contact uses in those reaches where such uses are desired and the chlorination effect is not detrimental to the maintenance of aquatic life; and, (5) a comprehensive program for further improvement of the water quality by augmentation of low flows, instream treatment, and/or other appropriate means; and, (6) an additional flow of at least 100 c.f.s. in the Cuyahoga River below Akron is mandatory to meet the proposed water quality criteria even after the highest degree of wastewater treatment reasonably attainable under present technology has been provided.

To reduce algal growths, extensive programs of nutrient control (phosphorous and nitrogen) should be pursued throughout the basin. Such programs to be effective should be applicable to all sewage discharges, industrial discharges and land run-off.

9. All apropriate agencies and other entities, i.e. the Ohio Water Commission, the Soil Conservation Service, U.S. Department of Agriculture, and Three Rivers Watershed District will be encouraged to implement programs for erosion control to reduce silt problems.

WATER POLLUTION CONTROL BOARD
DEPARTMENT OF HEALTH
COLUMBUS, OHIO

WATER QUALITY STANDARDS ADOPTED BY THE BOARD JANUARY 10, 1967, FOR THE MAUMEE, TIFFIN, ST. JOSEPH, AND ST. MARYS RIVER BASINS

The Ohio Water Pollution Control Board hereby adopts water quality standards for the following interstate waters:

(1) The Maumee River which flows from the State of Indiana through northwestern Ohio to Lake Erie;

(2) The Tiffin River which originates in southern Michigan and flows through Ohio to the Maumee River;

(3) The St. Joseph River which originates in Michigan, flows across the northwestern part of Ohio and into Indiana; and,

(4) The St. Marys River which originates in Ohio and flows into Indiana.

Further, the Ohio Water Pollution Control Board hereby adopts water quality standards for the following intrastate waters:

(1) All intrastate tributaries of the Maumee River; and,

(2) Tenmile Creek (Ottawa River in Toledo), Shantee Creek, and Otter Creek which are tributary to Maumee Bay.

Water Quality - Conditions and Criteria

All Waters. All the waters considered herein shall meet the following conditions at all times:

(1) They shall be free from substances attributable to municipal, industrial, or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits;

(2) They shall be free from floating debris, oil, scum, and other floating materials attributable to municipal, industrial, or other discharges in amounts sufficient to be unsightly or deleterious;

(3) They shall be free from materials attributable to municipal, industrial, or other discharges producing color, odor, or other conditions in such degree as to create a nuisance; and,

(4) They shall be free from substances attributable to municipal, industrial, or other discharges in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.

Stream-Water Quality Criteria for Various Uses adopted by the Ohio Water Pollution Control Board on June 14, 1966, shall apply to all waters under consideration herein, with the following two variances:

(1) Dissolved Solids: (For Public Water Supply)
Not to exceed 750 mg/l as a monthly average value, nor exceed 1000 mg/l at any time;

(2) pH: (For Industrial Water Supply and For Aquatic Life)
Not less than 6.5 nor greater than 9.0 at any time.

The Maumee River (1) from the Ohio-Indiana state line to the I-75 bridge near Rossford, shall meet the stream-water quality criteria for all uses; (2) from the I-75 bridge to Buoy No. 39 in Maumee Bay (the ship channel section of the river), shall meet the water quality criteria for industrial water supply and aquatic life (B); and (3) from Buoy No. 39 to the mouth of Maumee Bay which is near Buoy No. 33, shall meet the water quality criteria for all uses.

The Tiffin River from the Ohio-Michigan state line to its confluence with the Maumee River, and its tributaries, shall meet the stream-water quality criteria for all uses.

The St. Joseph River from the Ohio-Michigan state line to the Ohio-Indiana state line, and its tributaries in Ohio, shall meet the stream-water quality criteria for all uses.

The St. Marys River, and its tributaries, shall meet the stream-water quality criteria for all uses.

All tributaries of the Maumee River shall meet the stream-water quality criteria for all uses.

Tenmile Creek from its source to the Toledo city limits shall meet the stream-water quality criteria for all uses.

The Ottawa River in Toledo (Tenmile Creek), Shantee Creek, and Otter Creek shall meet the stream-water quality for industrial water supply and aquatic life (B).

Implementation and Enforcement Plan

The Ohio Water Pollution Control Board, under the provisions of Sections 6111.01 to 6111.03, 6111.31 to 6111.38, and 6111.99, Ohio Revised Code, has authority to control, prevent, and abate pollution in the waters of this state. In accordance with such authority, the Board hereby adopts the following program and requirements for the prevention, control, and abatement of new or existing pollution of the waters of the state considered herein:

(1) The design or critical flow defined as the minimum annual seven consecutive day warm weather flow which is exceeded in 80% of the years will be used in applying the stream-water quality criteria;

(2) All plans and proposals for abatement or correction of pollution will be approved by the Ohio Department of Health as required by law and such approvals shall constitute approval by the Board;

(3) All sewage will be given secondary treatment (biochemical oxidation), and the facilities to provide such treatment will be constructed and placed in operation without delay, and in no instance later than January 1, 1970;

(4) All effluents will be satisfactorily disinfected to meet the criteria for downstream water uses and the facilities to provide such disinfection will be installed without delay;

(5) All organic industrial wastes will be given secondary treatment and other constituents will be adequately treated to meet the water quality conditions and criteria, and the facilities to provide such treatment will be constructed and placed in operation without delay, and in no instance later than January 1, 1970;

(6) Local programs will be initiated to control and reduce pollution resulting from (a) bypassing, (b) spillages, and (c) discharges resulting from construction or breakdowns;

(7) Necessary studies will be made and, where feasible, plans and construction programs will be developed as rapidly as possible for reducing pollution from existing combined sewer overflows;

(8) Where necessary, supplementary treatment of wastewaters will be provided to the fullest extent consistent with current research and technological advances;

(9) The sustained stream flow plan included in the Northwest Ohio Water Plan adopted by the Ohio Water Commission is hereby made a part of this program and the implementation of this plan will be necessary to fully meet the water quality conditions and criteria; and

(10) Ohio's stream-water quality monitoring program will be expanded to adequately provide assurances of compliance with these standards.

Furthermore, the Board and the Ohio Department of Health will encourage and assist other agencies such as the Ohio Water Commission and the Soil Conservation Service, U.S. Department of Agriculture, in the implementation of effective soil erosion control programs, and programs for the reduction of the runoff of phosphorous, nitrogen compounds, and pesticides.

Enforcement of these requirements will be carried out by means of the respective permits issued to municipalities, counties, industries, and other entities discharging to the waters of the stream basins considered herein, and failure to comply with the permit conditions will result in legal action in accordance with the provisions of laws.

TO: City Officials, Consulting Engineers and Other Interested Persons
FROM: George H. Eagle, Chief Engineer, Ohio Department of Health
SUBJECT: Removal of Phosphates from Waste Waters

At the August 3-12, 1965, conference on pollution of Lake Erie, it was agreed upon by bordering States and Federal Water Pollution Control Authorities that municipal wastes be given secondary treatment and that "secondary treatment plants be so designed and operated as to maximize the removal of phosphates" in the Lake Erie Drainage Basin. Further, the water quality standard adopted by the Ohio Water Pollution Control Board for other basins throughout the state require supplemental treatment of wastewaters to the fullest extent consistent with current research and technological advances where necessary to reduce algae growth.

Subsequent to these requirements and agreements, municipalities were ordered by the Ohio Water Pollution Control Board to prepare general plans of wastewater treatment facilities for compliance. Most of the major municipalities complied with this order by employing consulting engineers to prepare general plans of the necessary improvements.

It soon became evident that very little was known about treatment for phosphates removal by either the consulting engineers or the state and federal agencies. As a result, general plans of wastewater treatment facilities submitted for approval and approved by this department practically ignored the matter of phosphate removal other than to state phosphate treatment facilities were being deferred until more was known about the matter.

Information furnished by the Federal Water Pollution Control Administration indicates there is a method by which phosphates can be removed at a low capital cost. This method involves the addition of sodium aluminate to the aeration tanks. It is reported the phosphate precipitates formed by the addition of sodium aluminate will not go back into solution or interfere with the disposal of sludge. It is also reported that the addition of this chemical will improve suspended solids removal in the final settling tanks and thus also improve the BOD removal efficiency of the plant. Other methods involving high capital costs have also been demonstrated to function satisfactorily.

It is recognized that the sodium aluminate phosphate removal process involves a high operation cost and it is hoped some other less expensive process will be developed before long. We cannot, however, continue to ignore the phosphate problem with the hope that some better process will develop at some future date. Future plans, both general and detail, of treatment plant improvements submitted to this department for approval will have to make some provision for phosphate treatment. At the present time, we do not know of any treatment process involving less capital cost than the sodium aluminate process.

March 28, 1968

To: City Officials, Consulting Engineers, County Sanitary Engineers, and other interested persons.

From: George H. Eagle, Chief Engineer, Ohio Department of Health

Subject: Sanitary Sewer Joints and Manholes

February 1, 1968

Overloading of sanitary sewers and sewage treatment plants resulting from excessive infiltration of ground or surface water is a serious problem in Ohio. At places where overloading is a problem and where surface and subsurface clean water connections are prohibited by ordinance or regulation, the overloading is caused by infiltration through leaking joints and manholes. Leaking sewers can be caused by unworkmanlike construction practices or by the use of unsuitable materials. Tight sewer systems are an absolute necessity if water quality objectives for Ohio waters are to be attained. In the future sanitary sewer plans will not be approved by the Ohio Department of Health unless the specifications conform to the following:

(1) Joints for vitrified clay bell and spigot pipe shall be compression joints as defined by ASTM Designation: C-425. Poured joints and joints of the slip seal type will not be approved.

(2) For concrete sanitary sewer pipe flexible watertight joints conforming to ASTM Designation: C-443 will be required.

(3) If satisfactory materials other than clay or concrete are used for sanitary sewer pipe the joints shall meet standards equal to the standards set forth above for clay and concrete pipe.

(4) Manholes shall be either poured-in-place concrete or precast concrete manhole sections. Precast concrete manhole sections shall conform to ASTM Designation: C-478 and the joints between sections shall conform to ASTM Designation: C-443.

(5) Revisions of the specifications referred to herein will be accepted provided the revisions up-grade the quality of sewer construction.

(6) Sanitary sewer specifications shall include provisions for testing the tightness of the sewer by an infiltration or exfiltration process or by any other approved process. The testing, as well as the sewer construction, must be under the direction of a qualified engineer or a competent inspector directed by an engineer.

(7) Building sewers shall be constructed in accordance with specifications equal to those indicated above.

(8) Sanitary sewer plans submitted for approval shall either be accompanied by separate contract specifications or sewer specifications noted on the plans.

O.D.H.

in the back of this.

MR. EAGLE: Yes.

CHAIRMAN STEIN: And understandably there was no numerical figure on your statement either on how much phosphates had to be removed.

MR. EAGLE: No, sir.

CHAIRMAN STEIN: It said they had to give consideration, as I read it here, to phosphate removal and they have to include some phosphate removal and that they describe the processes that had been recommended.

Are there any comments or questions on Mr. Eagle's report?

I think that in conjunction with the report we heard from Cleveland indicates we are moving apace in Ohio.

Do you have any other people you want to call?

MR. EAGLE: No, sir.

CHAIRMAN STEIN: Do we have any other requests?

I have a request from Charles Marquetta of Cleveland.

Now, sir, I see you are on a Council of Air and Water Pollution Control. We are only interested in the jurisdiction of water here.

MR. MARQUETTA: Well, this here -- it gets on your trees, roof, and in your gutters, in your sewer and the rain washes it to the river and the river takes it down into the lakes. I would like to demonstrate what this is.

CHAIRMAN STEIN: Would you identify yourself, first?

MR. MARQUETTA: Charles Marquetta from the Southeast Council Civic Club.

I demonstrated this a few times and it seems like it ain't getting anywhere. People don't understand what toxic dust and fumes is. They call it pollution, but I call it toxic dust. It is a magnet there, and that is out of my rain gutter. Anybody want to come up and look at it? It is right here.

MR. POSTON: This solid material from your rain gutter?

MR. MARQUETTA: That is from the rain gutter in three months, and that is in an area of about eight inches. That is what I was complaining about. It seems like it don't drip into people's minds what the people are breathing -- our children, our dogs and cats -- our trees are shedding around August. We got a lot of children up there, and people is getting cancer and heart trouble and all that sort of stuff, and that is the reason why our Medicare has gone up our hospitalization.

They have as high as from five to nine workmen from the steel mills down there at the Saint Alexis Hospital that are being pumped out every day. They take them in there and they put these tubes down in their throat or in their nose and they pump that black stuff out of them.

The men don't want to quit. They can't say anything, because they have been there 20 or 25 years. They want to retire. Now, I don't know why. You take the Saint Alexis Hospital there, the first breath of air a baby gets when he is born is that toxic dust, which goes down into the river, then down into the lake.

I don't know why they don't say it don't belong to water pollution because that is blown into the lake right from there. And I was down at Saint Vincent Charity Hospital down there -- they had to close the windows down there -- that is right here, the subject -- this same way at Saint Alexis, this same way with Cleveland Clinic. They smell it there.

Instead of getting cured, they pump that stuff right into them. I don't know what you guys are all talking about because they ain't done nothing to take that air out, that dust. Because if anybody comes in here with a vacuum cleaner and there is dust here and you don't put a bag in, you are going to spread it all over the floor here, and the same way with the water pollution you are talking about. Why should we dig up all that stuff anyway? If you dump in a quart of water to a hundred gallons of water -- I mean that polluted water into a hundred gallon of good water -- you would have to fill in the whole hundred gallon, so why not clean it right where it comes from?

FROM THE FLOOR: Let them pay for it.

MR. MARQUETTA: Yes.

Another thing is that we want to reduce water pollution. What do they do? They go out and they sell garbage disposal units, grind it up, and throw it down into the sewer. It goes in the river and down to the lake.

Now, it is easy for these mills or anybody to put settling tanks in, and catch it right there before it goes down into the river and goes down to the lake, but they don't want to do that. They want us to pay for it, make us sick and everything.

All the machinery gets that fine dust and toxic fumes and air right into them -- like that machinery right there -- it gets in your distributor; it gets in your gas; it gets into everything you do. When you open the door, it comes into the store. It gets into the meat. Nobody seems to be doing anything -- a lot of talking.

Heck! I have got all that stuff home there that I threw away. You go down, you want to talk to someplace, you stay there maybe a week, you make out a speech you are going to tell, you get down there and they won't let you talk.

FROM THE FLOOR: That is right here in this great city of ours.

MR. MARQUETTA: That is what I thought you were going to do here, too, but finally I got here, and I thank you very much.

CHAIRMAN STEIN: You are welcome. (Applause)

Well, thank you. I told you we are here to hear this.

MR. MARQUETTA: I am very glad you did.

CHAIRMAN STEIN: Mr. Chascsa has asked us to put this material into the record and without objection this will be done.

MR. CHASCSA: The wheel that squeaks gets the grease, noted in the Plain Dealer on June 4, 1968. Seven hundred million dollars have been asked for and $400 million have been authorized. So the Administration asks for $225 million. What is wrong? Isn't pollution worth the cost and fight?

How many Congressmen, Senators, State Representatives, etcetera, have had their ears pinned back for speaking out against the very thing we are trying to eliminate? Pollution is not created by us humans. It is created by Japanese beetles, farm silt, septic tanks, improper drainage, autos, etc., if you can make yourself believe it.

In England recently an oil tanker broke up creating a pollution problem; in Lake Michigan an unknown culprit created a 75-mile long oil slick; in Lake Erie recently at Bolles Harbor hundreds of fish were killed and were washed up on the beach -- cause unknown. Lake Huron alewife problem closes beaches, etc., "tragic," but isn't someone empowered to act in behalf of the people to protect their interests in these waters? Page 5833, Title 33, "Navigation and Navigable Waters," Chapter 407, is quite clear on what is to be done and who for several decades would be empowered to enforce this Act. So, for 40 or 50 years this Act has been lax, not enforced, and the result is evident.

In Lake Michigan, the Army Corps of Engineers Engineering News Record, October 26, 1967, Page 17, on one operation created a bigger problem by removing the filth created by Inland Steel through the removal of this filth and depositing it eight miles out into the lake. Does this shorten the alewives life span? Does this cause the death of hundreds of gulls and ducks? The Army Corps of Engineers say they are only helping to keep navigation open. Do you help navigation by dumping filthy oil, sewage, paper pulp and other settlings of our rivers such as the Cuyahoga, Detroit, Rouge, Maumee and others into shallow, dying Lake Erie? Let's resuscitate Lake Erie while it is still possible.

In 1967 some 7,015,000 cubic yards of this filth went into Lake Erie. Seventy percent was not confined to diked areas, only the thirty percent. It is estimated that over 75 percent will find its way into unprotected areas of the lake in 1968, and already a clamor is being raised for permission to dump almost 500,000 cubic yards into the lake this year from one area alone. There are 23 such dumps in Lake Erie alone.

Will the $700 million requested from Uncle take care of this problem also? No! Only the sincere and honest efforts of the Department of the Interior, Army Corps of Engineers, conservation departments, and health departments and the determined efforts of our engineering sciences with the cooperation of industries as well as John Q. Public.

Inland settling ponds were suggested to store water. We already have lakes; let's keep them clean and we won't need to create artificial sources of water.

We can build 500,000 to 1,000,000 ton capacity oil tankers, ("Business Week", page 120, April 6, 1968) spend zillions to send a bunch of steel and equipment to the moon, and still haven't the ability to keep the very necessities, that are essential to our survivial, clean and unadulterated. Other areas and countries close down offenders. Why don't we?

Every industry should have a method of disposing of its waste before it is permitted to begin to operate. It is not the responsibility of the public to provide this service. That is why we have the Army Corps of Engineers, Coast Guard, conservation commissions, health departments and on and on. But we also have pollution of our air and water and excuses too. Long extensions to comply should be discharged and the Army Corps of Engineers should be the last to request an extension.

We have the know-how -- let's use it.

(News clipping follows.)

"Water to be Injected Deep in Ground.

"Reservoir Idea is Tested.

"A way of storing fresh water by injecting it through wells into subsurface rocks is being tested by hydrologists of the Geological Survey of the Department of the Interior and the city of Norfolk, Virginia, reports the New York Times.

"If successful, the method of underground water storage may have far-reaching applications in many coastal areas where surface storage is difficult or expensive.

"Donald I. Brown, hydrologist at the Geological Survey office in Norfolk, says that 'while experiments involving techniques for storing fresh water underground are not new, this will be the first time that such huge amounts of water may be involved.'

"'It is hoped that hundreds of millions of gallons of fresh water will be stored underground, and held in reserve for long periods of time, perhaps for several years,' he said.

"Mr. Brown said that a test injection well was being drilled in Norfolk that would explore the aquifiers (water bearing sands) deep beneath the city. So far, the well has indicated that bedrock may be as much as 2600 feet below the surface. The well has already passed through all the formations expected to contain useful productive water-bearing materials.

"'If the information from the test well is favorable,' Mr. Brown said, 'other injection wells will be constructed, and we will begin to test the feasibility of recharging these aquifiers, and thus build up a fresh water reserve.'

"The test well is being drilled at the Moore's Bridge Filter Plant," reports the Times. "Treated water in excess of the daily needs of Norfolk will be supplied for injection from the plant."

Letter from Mr. W. F. Carbine, United States Department of the Interior, Fish and Wildlife Service, Bureau of Commercial Fisheries, 5 Research Drive, Ann Arbor, Michigan, 48103, dated April 25, 1968, to Mr. John Chascsa, President, Lake Erie Cleanup Committee, 7231 Center, Estral Beach, Newport, Michigan, 48166:

"Dear Mr. Chascsa:

"This acknowledges receipt of your April 4 note concerning the application of the Dunbar-Sullivan Dredging Company to dredge spoil from the Route River area and deposit it into Lake Erie west of the Detroit River Light. We in the Bureau of Commercial Fisheries certainly do share your alarm with respect to the effects of the proposed work would have on Lake Erie.

"Details of this proposed dredging project are being reviewed by this Bureau, the Bureau of Sport Fisheries and Wildlife, and the Federal Water Pollution Control Administration. At this writing a joint position is being prepared for the above Department of Interior Agencies by Mr. Charles Stoddard, Interior's Upper Mississippi-Great Lakes Coordinator. When completed this position with recommendations will be presented to the Corps of Engineers. I am certain Mr. Stoddard would like to hear from you on this matter. His address is: Mr. Charles A. Stoddard, Regional Coordinator, Upper Mississippi-Western Great Lakes Area, 6201 Congdon Boulevard, Duluth, Minnesota, 55804.

"I appreciate your calling this situation to our attention. If we can be of further assistance on this matter, please let us know.

"Very truly yours, W. F. Carbine, Regional Director."

Letter from the United States Department of the

Interior, Federal Water Pollution Control Administration, Washington, D.C., 20242, dated April 9, 1968, to Honorable Marvin L. Esch, House of Representatives, Washington, D.C., 20515.

"Dear Mr. Esch:

"This is in reply to your communication of March 25, 1968, enclosing a letter from Mr. John Chascsa, President of the Lake Erie Cleanup Committee, concerning effects of dredge spoil disposal on the water quality of Lake Erie.

"Mr. Chascsa elaborates on many facets of the problems encountered with the disposal of dredged materials from waterways and industrial harbors that often contain high concentrations of pollutants. We agree that open water disposal of polluted spoil material should be discontinued. In advice given the Corps of Engineers with respect to requests for dredging permits in the Great Lakes, the Federal Water Pollution Control Administration has consistently urged that polluted dredged spoil be disposed in a controlled manner and not open casted.

"We also agree with Mr. Chascsa that each pollutor is primarily responsible for his own waste control. Strong efforts are underway to control waste discharges from the industrial and municipal complex tributary to the Detroit River. The Federal-State Enforcement Conferences for both Lake Erie and the Detroit River established January 1970 as the date by which all pollution from these sources is to be controlled.

"Your interest in and support of water pollution control are appreciated.

"Sincerely yours, John M. Rademacher, Director, Division of Technical Services."

Letter from United States Department of the Interior, Office of the Secretary, Washington, D.C., 20240, dated September 19, 1967, to Honorable Marvin L. Esch, House of Representatives, Washington, D.C., 20515.

"Dear Mr. Esch:

"Secretary Udall has asked me to reply to your letter of August 25, 1967, concerning the disposal of material to be dredged adjacent to the Great Lakes Steel Corporation dock in the Detroit River at Ecorse, Michigan.

"The Director of our Great Lakes Regional Office, Federal Water Pollution Control Administration, reviewed the application for permit submitted by Dunbar and Sullivan Dredging Company, and recommended to the District Engineer by letter of August 15, 1967, that the dredged material be placed on land or in a diked area to avoid pollution of Lake Erie.

"Sampling of bottom sediments in the vicinity of the Great Lakes Steel Corporation dock was carried out by the Federal Water Pollution Control Administration in

1963. The material consisted mainly of silt, organic ooze, and clay, mostly gray to black in color, with a strong odor of sewage and oil. Examination of benthic organisms showed a large population of pollution tolerant worms. Chemical analyses indicated high concentrations of nitrogen and phosphorous compounds.

"The potential sources of the organic materials are not significantly changed since the 1963 samplings. Hence, the pollutional characteristics of the materials to be dredged would be expected to be similar to the 1963 samples and further analyses at this time would not seem necessary to support our recommendation that the dredged materials be disposed of in a manner that will prevent pollution of the lake waters.

"Your sincere interest in water pollution control is appreciated.

"Sincerely yours, Elino R. Morgan, Deputy Assistant, Secretary of the Interior."

Letter to Michigan Water Resources Commission, Ann Arbor, Michigan, dated February 19, 1968.

"Water Quality Conference.

"Michigan's most precious heritage, water.

"Why is it necessary to ask people what quality water they want? Why, after all the investigations, conferences, studies and experiments is it necessary to ask: do you want safe water or prosperity through industry and large cities?

"After seventy-five years or more we pride ourselves on our know-how in making water safe to consume and air to breathe and still when we look about, we find our papers, magazines, radio and television calling our attention to the filth in our waters and air. Did it ever occur to any of our health officers, conservationists, public officials, engineers, scientists, industrialists and developers that at times the chemicals used to safeguard our waters are just as injurious to some humans as the polluted water.

"We are aware that relaxation with water sports is a growing need, clean fresh water is needed more than ever for our growing population, industries are ever clamoring for sites near fresh water, commercial fishermen need clean water to ply their trade and on and on. How do we keep these waters in a suitable, palatable, and refreshing condition? By asking the people who eventually pay the bill: 'What quality of water do you want?' Then frighten them off by telling them they must choose between prosperity and clean healthful water, or to have these people pay for the cleanup.

"How do you use a stream, pond, river, or lake as a multipurpose source?

"How can you set a standard for an area in a stream, pond, river, or lake today and expect it to be the same two, five, or ten years from today? Huron River, River Rouge, Raisin River, Pine, Swan Creek, Clinton, Stony Creek, Detroit River, St. Clair Lake and Lake Erie are prime examples of multiple uses without long-range planning or proper supervision. There is but one solution, enforcement of Water Resources Commission Acts of 1929, making all State waters safe for body contact and use the 'No Further Degradation of Our Waters' slogan and mean it.

"We of the Lake Erie Cleanup Committee sincerely urge the State Water Resources Commission to discourage any new permits to use our waters for any indiscriminate use or as a dump for unwanted wastes, to lessen the danger to wildlife, fish, and humans, as well. Make our waters safe for any and all uses, especially for body contact, sports and human consumption.

"Respectfully submitted, Lake Erie Cleanup Committee, Inc., John Chascsa, President."

Statement by Lake Erie Cleanup Committee, Newport, Michigan, 48166.

"The Rape of a Water Wonderland.

"A gruesome title, no doubt, but true.

"In the July 1962, issue of the Reader's Digest there appeared an article on Page 151, titled 'The Rape of our Southern Mountains.'

"Every American should have read it, every voting American should have read it, and every voting American should have remembered it. Every penny budgeting housewife and sportsman and every conscientious Christian should have read it and done something about it. Even if he only hung his head in shame.

"To commercialize on the gullibility of poor hill folks is not Christian. To abuse the stature of being a businessman by destroying the lifeblood of those of our citizens through so-called shrewd business manipulation is certainly un-American and un-Christian.

"When we, as individuals, resign ourselves to a state of deplorable complacency by accepting the do-nothing bureaucrats who spend our money as well as set the amount of tribute, we must pay to maintain these bureaucrasies as something we have no power or say-so about then we are lost.

"We elect men to represent us in various phases of government to do our bidding and to help us determine the best course to follow. Unfortunately, only a very few take their oath seriously, and very few attend all sessions that are held in Washington and in our State and County legislative capitals.

"We have created agencies and commissions and various study groups and frankly, I believe the committee studying the sex life of the gnat is about the most capable of submitting an acceptable report, if there is such a committee.

"Since the late 1870's we have had one after another anti-pollution committee created. We have a geological study going on in the Great Lakes for many years; geologists, biologists, conservationists, health authorities, and many, many more who have compiled tons and tons of reports. In the past forty, fifty, or sixty years we have bragged of our intelligence and know-how, to do more and better than any other Nation on earth. We have proven that man can fly, send rockets and missiles anyplace on earth and probably to the moon and we haven't skimped on the cost of these experiments, in spite of the staggering amount. Yes, we should be proud of our so-called accomplishments. We should be very proud and very humble in dealing with our less fortunate neighbors also, no matter who they are.

"The trip to the Moon Commission has never been denied their request for funds, these are always available.

"The committees on pollution study, water, health, public safety, sanitation and many environmental aspects of our well-being have been belittled and slighted and pushed aside after almost a whole decade of studies, until today we suddenly realize the importance of safe, clean water. Of what earthly use are all the facts and figures gathered in the past fifty years to us? We permit lobbyists to legally have our laws changed to suit their clients' wants. We disregard the riparian rights of the little guy (who is all-important at election time) and forgotten after election.

"In 1961, Governor John B. Swainson was asked to call the United States Public Health Service in to study the pollution problem in the Detroit River, Lake Erie, Lake St. Clair, Huron River, River Raisin and many smaller tributaries leading into our lakes. What was the real reason? Did someone feel sorry for the plight of the residents along the Detroit River, Lake Erie or was there another reason? Did the pipedream of the Detroit and Wayne County planners backfire when they found their plan for another Italian Venus type of island chain, in the Harsens Island area, filtered silt into their water supply station at Belle Isle? Remember the screaming public demanding to know what went wrong? Why the bad taste? Why the industrial waste, et cetera? Was this a way to get Federal funds to pipe water from Lake Huron? Perhaps it would be interesting to note the chain of events prior to and after the SOS for all the people under Federal jurisdiction to come to the aid of the large metropolis of Detroit. Oh yeah, we all pay Federal taxes and only the large cities and those with pull are worthy of getting any finances for the things needed to maintain good health and other necessities of which we hear and are told. We should have to be good citizens and healthy Americans.

"Most small communities cannot afford even a trip to Washington to seek assistance; however, one of our more ambitious mayors requested fifty thousand dollars to maintain an office in Washington to be nearer the source of Federal grants, loans and gifts. Thanks to Councilwoman Beck, it was defeated.

"You may say, what has all this to do with pollution? Well, let us look back a bit on the 27th and 28th of March 1962, a conference was held at the Veterans Memorial Hall in Detroit. The findings of the United States Public Health Service substantiated that there was definite cause for a thorough investigation into the cause of pollution. This was substantiated by written and oral evidence by many State agencies, the Army Corps of Engineers, various sportsmen clubs, and a citizens' group known as the Lake Erie Cleanup Committee who not only submitted written evidence, but also 29 jars of water in various degrees of pollution taken at 29 separate locations, ranging from the Toledo-Ohio State line to and including River Raisin, Lake Erie, Swan Creek, Huron River, Detroit River, and River Rouge.

"A statement was made at this conference that the people in the Lake Erie and Monroe area couldn't possibly have such a problem. One of Detroit's leading citizenry even went so far as to state that a little refuse doesn't hurt anyone and that perhaps he would be asked to put diapers on the wild ducks flying over these waters so it could stay clean. A very intelligent remark to be made by a man who is looked up to by many. In a recent statement to the press he ridiculed the United States Public Health personnel for doing a thorough job. (I know it was thorough because I personally followed all or almost all of the study). When others of our organization were able, they also followed the progress. According to this man's statement this was all a waste of time and uncalled for, the water quality is so much more improved and has been on the upgrade since 1940."

Letter from Lake Erie Cleanup Committee, Newport, Michigan, 48166, dated April 11, 1968, to James T. White, Jr., Colonel, Corps of Engineers, District Engineer, P. O. Box 1027, 150 Michigan Avenue, Detroit, Michigan, 48231.

"Subject: Proposed Dredging in Detroit River, No. NCECO-0-09.

"Dear Colonel White:

John Chascsa

"Several weeks ago the Lake Erie Cleanup Committee filed a protest against the March 12, 1968, request of Dunbar and Sullivan to be permitted to use Lake Erie as a disposal site for waste from the Rouge River amounting to 105,000 cubic yards. On April 10 I received from Mrs. Finck a copy of a notice from your Department displaying a request from Dunbar and Sullivan for permission to dispose the waste from the Detroit River dredging, amounting to 190,000 cubic yards, into Lake Erie, making a total of 295,000 cubic yards of filthy, foul-smelling, nuisance creating health hazard, which will (As you well know) create a nuiscance and hamper navigation and create a filthy situation on the beach at Pointe Mouillee and Estral Beach and Stony Point. In 1962, the first conference held in Detroit, it was agreed by all concerned that this was a bad practice and your Department would find other means of disposing of this so-called 'gook.' It is now 1968, and outside of the publicity picture in the Detroit News, showing a pipeline being used to empty a dredge and deposit the waste on Grassy Island, the indiscriminate dumping goes on and the public still has to be restricted from using the lake as a source of water recreation.

"I have always held the engineering sciences in high esteem, but today with all the errors made in many fields of engineering, my doubts are becoming more and more aroused.

"If industry can spend millions to bring filth into an area they can also spend it to take it out and not expect the public to do it. I am sure you can see the logic in this. Look at the situation created by the Detroit Disposal Plant. It cannot be denied that it is responsible for the necessity to dredge the Detroit River in a very large degree and still, all the Federal and State agencies feel they should be able to convince the public to assist in enlarging the system to include more industrial as well as residential users to take advantage of Detroit's offer.

"I don't recall your Department opposing a mammoth sewer system reaching from Flint to the Huron River. I don't recall your Department making suggestions or recommendations to prevent industrial wastes from entering the rivers or lakes by re-using their oil, acids, and other industrial solvents and oil refinery wastes.

"It is hoped by this group that you will be able to convince Dunbar and Sullivan that it is very much past the time of free dumping grounds and time to cooperate with health and conservation officials, also for the sake of humanity.

"Respectfully submitted, John Chascsa, President

Lake Erie Cleanup Committee."

Letter to Honorable Marvin L. Esch, Congressman, 1421 Longworth Building, Washington, D.C., 20515, dated March 13, 1968, from Lake Erie Cleanup Committee, Newport, Michigan, 48166.

"Dear Congressman:

"Many thanks for the information on the Army Corps of Engineers pilot project for Lake Erie. It is very interesting and if properly employed could be of great benefit to all concerned. I have a copy of the Army Corps Trenton Channel deepening project in front of me as I write. The description and planning call for an expenditure of $31,300,000 plus $15,000 additional for annual maintenance. Nowhere do I see any guarantee that the proposed turning basin will not serve the same purpose as the Port of Monroe turning basin. The oil, refuse, and paper pulp in the Monroe Basin is not, as is supposed, a product of siltation and I feel the same will be and is at present in the Trenton Channel. Another $53 million would open a channel to the shipping lane. Is it worth it? Will steel be cheaper?

"If, as Colonel James T. White states in his February 16, 1968, letter to you, the St. Lawrence Seaway is such a critical economic life line, why does it behoove him to use any of the shallow or deep waters of Lake Erie as a dump for any material polluted or not? If the bottom at Bolles Harbor is free of pollution it could and should be deposited on a suitable shoreline site where it could be carted away to an area where it would serve a useful purpose, instead of hampering boating and marine life, and otherwise creating an illusion of eutrophication in an already overburdened Lake "Eerie" Erie? **There is no real deep area in Lake Erie for any type of dump. As** I have mentioned in previous statements there are twenty-three dumps in Lake Erie at present, these have had the blessing of the Army Corps of Engineers for many years, and the results are very evident even to the odor. Let's close them all.

"Is Trenton Channel turning basin also to become a catchall for all downriver industrial and municipal waste, or are we going to ask each pollutor to remove all his waste before spending a penny of public funds to aid in the so-called economic lifeline development? It is time to quit kidding one another or let everything and anything go and forget we have a problem until large scale epidemics are upon us, then raise the devil.

"As has been stated so many times, with all the studies that have been made and are being made, our scientific and engineering brains can find a much more profitable use for our waste and certainly a more satisfactory one for all.

"The Colonel states that in forty years no history of polluted beaches exists. For the past ten years almost all of the shoreline of Lake Erie is or has been considered polluted vis Sterling State Park. I am certain the Department of Interior would concur with the sentiment as expressed herein.

"Hoping this will be considered by yourself and other interested representatives and authorities as just cause to take proper action, I remain,

"Sincerely, John Chascsa, President, Lake Erie Cleanup Committee."

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1027 150 MICHIGAN AVENUE
DETROIT, MICHIGAN 48231

IN REPLY REFER TO
NCECO-O 09

20 March 1968

PUBLIC NOTICE

PROPOSED DREDGING IN DETROIT RIVER NEAR DETROIT, MICHIGAN

1. When an application is received for a Department of the Army permit to authorize work in or over a navigable water of the United States Department regulations state that notice regarding the matter shall be sent to all persons deemed likely to be interested in order that any protests from the standpoint of navigation or other pertinent factors may be presented.

2. Dunbar and Sullivan Dredging Company, 2312 Buhl Building, Detroit, Michigan, has applied to this office for Federal permits to dredge at the following locations in the Detroit River as shown on the attached sheets with all dredged material to be deposited on the authorized dumping ground in Lake Erie West of Detroit River Light.

Location of Dredging	Volume of Material to be dredged
a. Detroit Processing Terminal	10,000 cubic yards
b. Great Lakes Steel Corporation	25,000 cubic yards
c. Nicholson Terminal and Dock Company	50,000 cubic yards
d. Federal Marine Terminals	10,000 cubic yards
e. Detroit Harbor Terminals	10,000 cubic yards
f. Great Lakes Steel	35,000 cubic yards
g. Nicholson Transit Company	50,000 cubic yards
	TOTAL 190,000 cubic yards

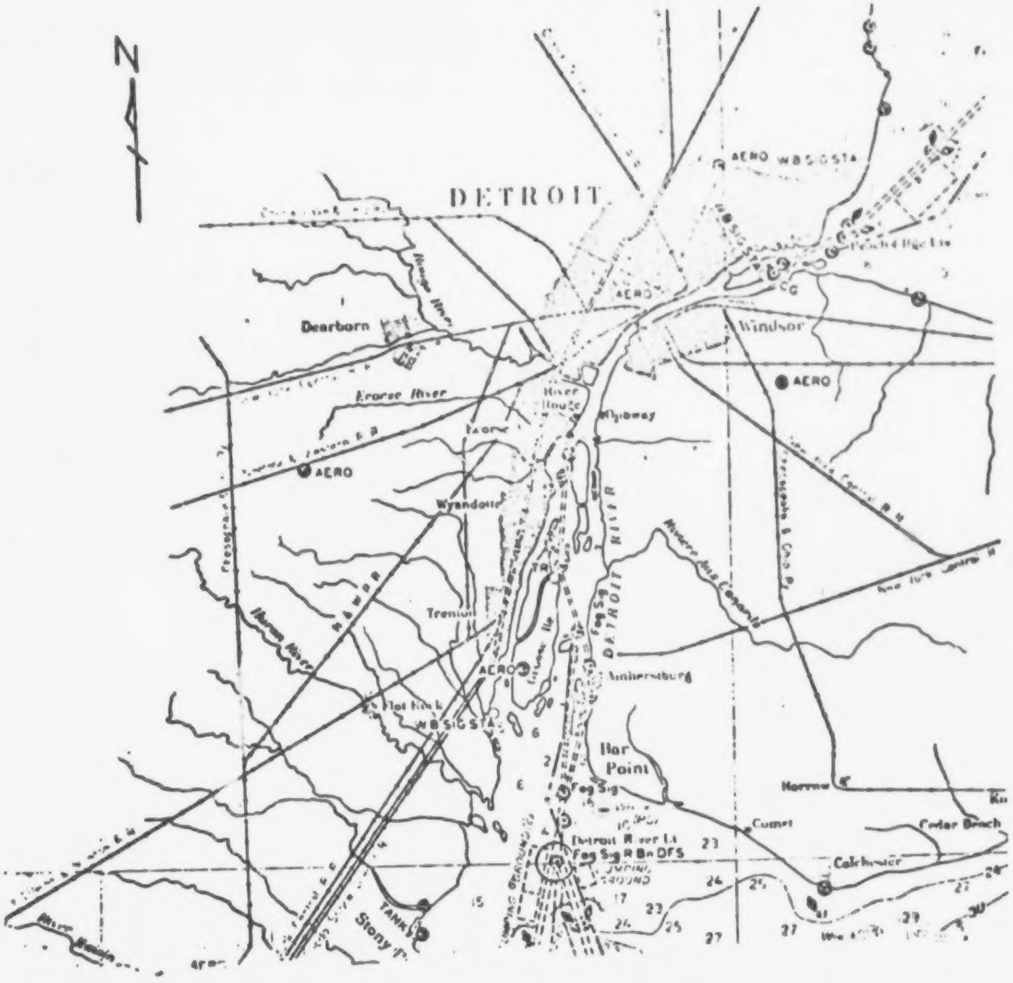
3. Any interested party entertaining objections to the proposed operations should file written protests thereto with this office not later than 4:30 P. M., Eastern Standard Time, 19 April 1968. The determination as to whether a permit will be issued will be made after due consideration of the effect upon navigation, fish and wildlife, pollution, conservation and other pertinent factors of general public interest. Objections should be specific in describing the reasons upon which the protest is founded.

JAMES T. WHITE, JR.
Colonel, Corps of Engineers
District Engineer

Notice to Postmasters:

It is requested that the above notice be conpsicuously and continuously posted until 20 April 1968.

Process No. 68062

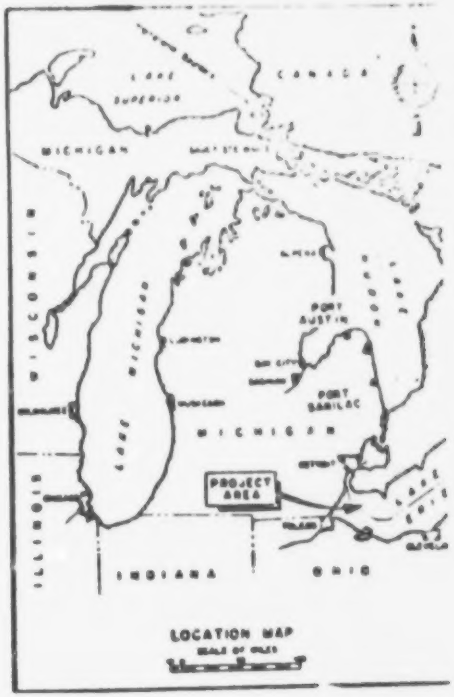

N
DETROIT
AERO WBSIGSTA
Dearborn
Windsor
AERO
Ecorse River
Wyandotte
Trenton
DETROIT RIVER
Amherstburg
Flat Rock
WBSIGSTA
Bar Point
Fog Sig
Detroit River Lt
Fog Sig RBn DFS
DUMPING GROUND
Colchester
Cedar Beach
Stony Pt
TANK

TRACED FROM CHART #41 U.S. LAKE SURVEY

VICINITY MAP

SCALE OF FEET

1000 500 0 1000 2000 3000 4000


LAKE SUPERIOR
CANADA
MICHIGAN
WISCONSIN
LAKE MICHIGAN
LAKE HURON
PORT AUSTIN
PORT SANILAC
MICHIGAN
PROJECT AREA
ILLINOIS
INDIANA
OHIO
LAKE ERIE
LOCATION MAP
SCALE OF MILES

Proposed Dredging and Disposal

Application by:
Dunbar & Sullivan
11 January 1968

751<

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1027   150 MICHIGAN AVENUE
DETROIT, MICHIGAN 48231

IN REPLY REFER TO
NCECO-O 09

12 March 1968

PUBLIC NOTICE

PROPOSED DREDGING IN ROUGE RIVER AT DETROIT AND RIVER ROUGE, MICHIGAN

1. When an application is received for a Department of the Army permit to authorize work in or over a navigable water of the United States, Department regulations state that notice regarding the matter shall be sent to all persons deemed likely to be interested in order that any protests from the standpoint of navigation or other pertinent factors may be presented.

2. Dunbar and Sullivan Dredging Company, 2312 Buhl Building, Detroit, Michigan, has applied to this office for Federal permits to dredge at the following locations in the Rouge River as shown on the attached sheets with all dredged material to be deposited on the authorized dumping ground in Lake Erie West of Detroit River Light.

	Location of Dredging	Volume of Material to be Dredged
a.	International Salt Company	20,000 cubic yards
b.	Marathon Oil Company	10,000 cubic yards
c.	Sun Oil Company	10,000 cubic yards
d.	Allied Chemical Company	10,000 cubic yards
e.	Detroit Marine Terminals	15,000 cubic yards
f.	Scott Paper Company	10,000 cubic yards
g.	Detroit Lime Company	20,000 cubic yards
h.	Marathon Oil Company	10,000 cubic yards
		105,000 cu yds.

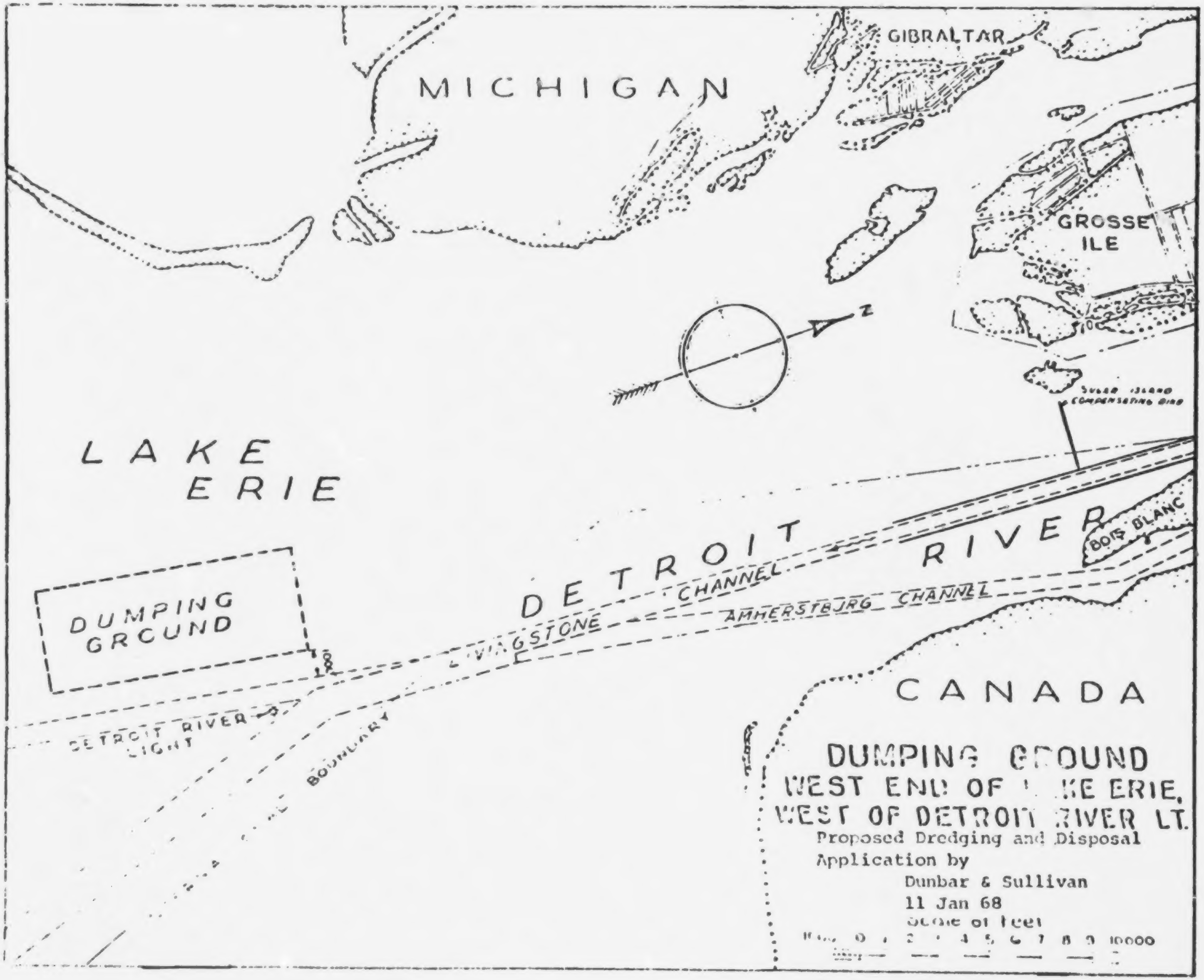
3. Any interested party entertaining objections to the proposed operations should file written protests thereto with this office not later than 4:30 P. M., Eastern Standard Time, 11 April 1968. The determination as to whether a permit will be issued will be made after due consideration of the effect upon navigation, fish and wildlife, pollution, conservation and other pertinent factors of general public interest. Objections should be specific in describing the reasons upon which the protest is founded.

JAMES T. WHITE, JR.
Colonel, Corps of Engineers
District Engineer

Notice to Postmasters:

It is requested that the above notice be conspicuously and continuously posted until 12 April 1968.

Process No. 68069

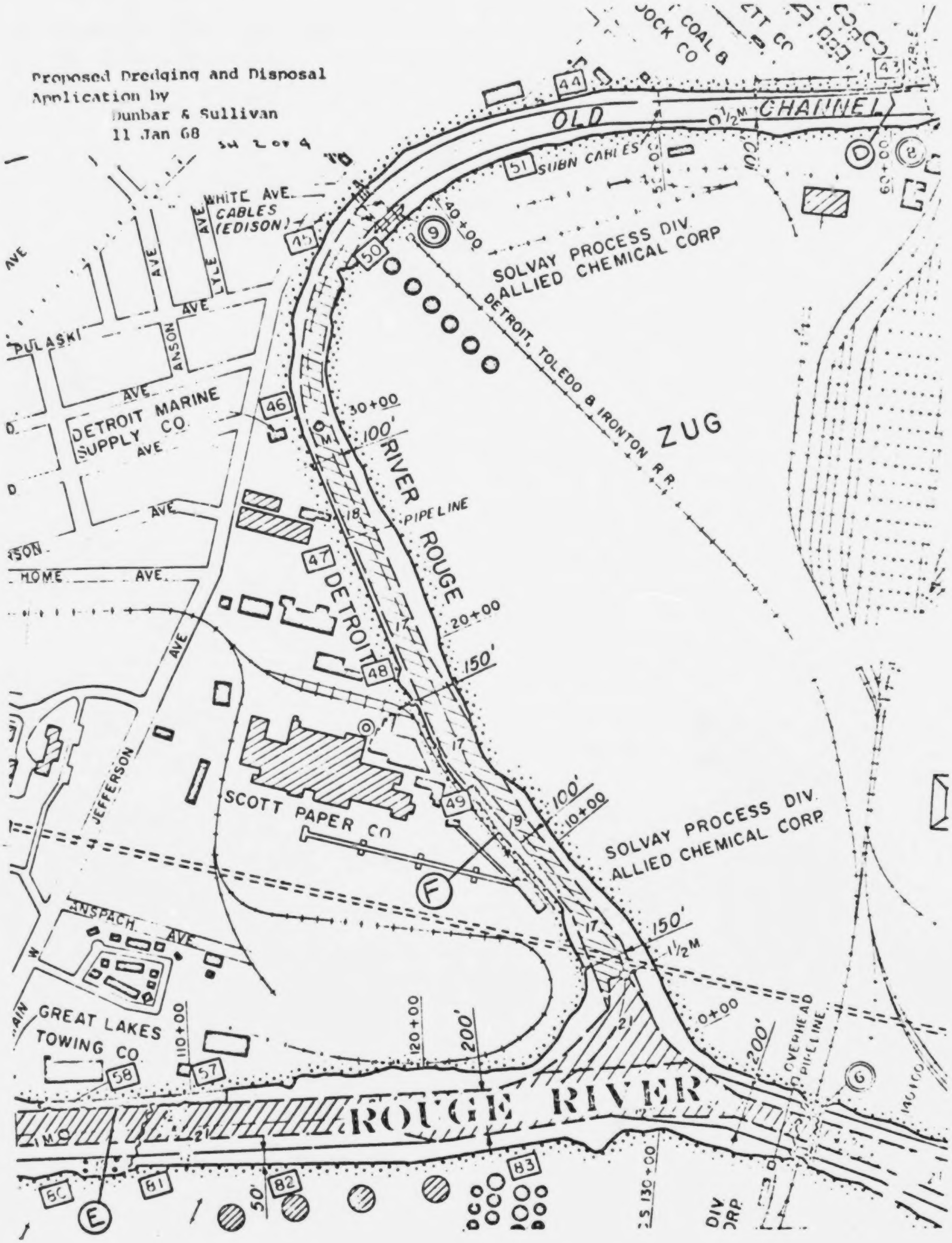


DUMPING GROUND
WEST END OF LAKE ERIE,
WEST OF DETROIT RIVER LT.
Proposed Dredging and Disposal
Application by
Dunbar & Sullivan
11 Jan 68

MICHIGAN
GIBRALTAR
GROSSE ILE
N
SUGAR ISLAND COMPENSATING DIKE
LAKE ERIE
DETROIT RIVER
BOIS BLANC
DUMPING GROUND
1000
LIVINGSTONE CHANNEL
AMHERSTBURG CHANNEL
DETROIT RIVER LIGHT
BOUNDARY
CANADA
Scale of feet
0 1 2 3 4 5 6 7 8 9 10000

Proposed Dredging and Disposal
Application by
Dunbar & Sullivan
11 Jan 68

SH 2 OF 4


OLD CHANNEL
COAL &
DOCK CO
SUBN CABLES
WHITE AVE.
CABLES (EDISON)
SOLVAY PROCESS DIV. ALLIED CHEMICAL CORP
DETROIT, TOLEDO & IRONTON R.R.
ZUG
PULASKI AVE
ANSON
LYLE AVE
DETROIT MARINE SUPPLY CO
HOME AVE.
JEFFERSON AVE
RIVER ROUGE
DETROIT
PIPELINE
SCOTT PAPER CO
SOLVAY PROCESS DIV. ALLIED CHEMICAL CORP.
ANSPACH AVE
GREAT LAKES TOWING CO
ROUGE RIVER
OVERHEAD PIPELINE
40+00
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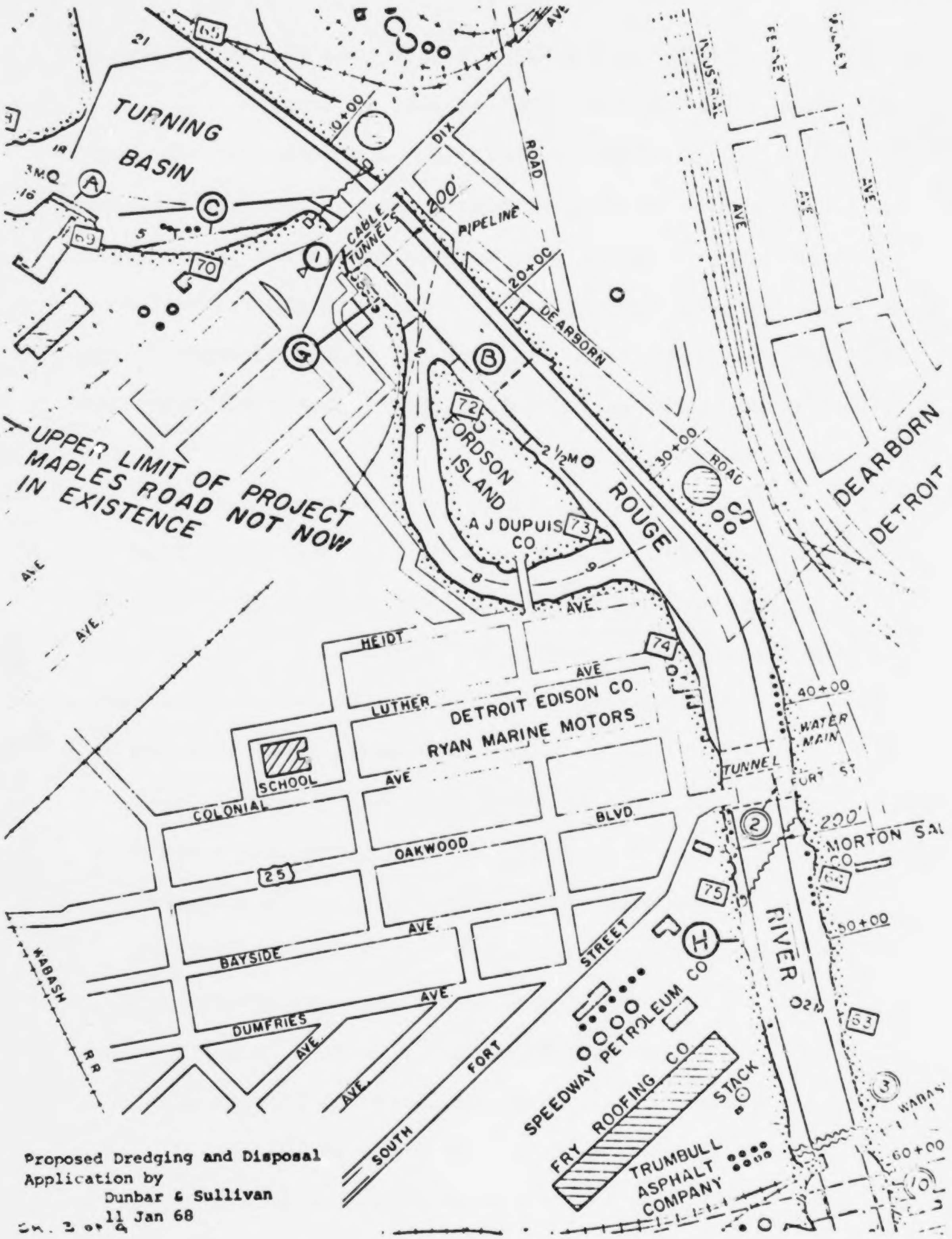
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UPPER LIMIT OF PROJECT
MAPLES ROAD NOT NOW
IN EXISTENCE
FORDSON ISLAND
A J DUPUIS CO
ROUGE
RIVER
ROAD
DEARBORN
DETROIT
AVE
HEIDT
LUTHER
AVE
DETROIT EDISON CO.
RYAN MARINE MOTORS
SCHOOL
COLONIAL
BLVD
OAKWOOD
25
BAYSIDE
AVE
DUMFRIES
AVE
WABASH
RR
SOUTH
FORT
STREET
WATER MAIN
TUNNEL
FORT ST
200'
MORTON SA
CO
SPEEDWAY PETROLEUM CO
FRY ROOFING CO
STACK
TRUMBULL ASPHALT COMPANY
WABAS

Proposed Dredging and Disposal
Application by
Dunbar & Sullivan
11 Jan 68
Sh. 3 of 9

CHAIRMAN STEIN: We now have Mr. Jack Kinny who wants five minutes. That is what it says.

MR. KINNY: Conferees, I thought for the last five minutes of this morning's session that the committee was going to settle down to determine where it was going and why, and then we got back into the generalizations, and then later this afternoon Mr. Metzler brought it up once more that we had better know a little bit more about where we are going.

I want to commend Pennsylvania. I thought that would be the last State I would ever hear to propose determining what actually was going on in the river. They have been living on effluent standards for so long.

Somewhere along the line we are going to have to find out what we are accomplishing with the money we are spending, and from the practical viewpoint it was touched on this morning, and this is the one point that I would emphasize: The Administration has proposed a cutback on Federal grants to $225 million. The best indication is that the Congress will appropriate something less than $150 million. What this is going to do to a program that has become geared to Federal grants is nothing other than putting on three of the four brakes.

There has been a proposal for an alternative in financing, but it is, in my opinion, something that can do us more harm than good. It could be a face-saver for the moment, but it could be a real drawback for the whole program in the longrun.

I don't know whether you have heard the remark that assumption and inexperience are the mother and father of all goof-ups. We have gone through a good deal of this kind of an approach with water pollution. I would hate to see one more approach of juggling the financing at this stage of the game, and I offer this with the idea that if the conferees are going to set some time schedules, rather than come up with something that is going to have to be shifted once more, that the realities of the present financial condition bear its weight in making the decision.

With respect to Mr. Metzler's suggestion that says if we are going to go for the phosphate picture, we better determine in advance that that will give us the result. Now, I do know that there are many scientific illiterates that argue we do whatever we can do and anything we can do is in the right direction. But sometimes that means digging a hole and then moving it. There are many things we should do now before the public is promised that 80, 85, 90 per cent removal will eliminate algae, only to find out that it doesn't.

One last caution! In the introduction to the

Federal report, the first sentence was: "Although Lake Erie is still an excellent source of municipal raw water, the effects of pollution are becoming evermore and more discernible." The next sentence: "That dissolved solids have decreased by 9 per cent since 1964."

This, the general public could take as meaning we are going from bad to worse, and it bothered me until I took a look at the data, and I would commend to the committee's attention on Page 32 a comparison between the Detroit and the Cleveland offices for suspended solids; the difference between the two offices themselves were around sixty per cent. Some of these analyses show 300 per cent difference.

We are talking about concentrations so low that these relative concentrations cannot be compared with the sanctity that this kind of suggestion would offer, and I would hope that what the conferees are doing is promoting a program of progress rather than -- well, these may read well, and to some newspaper people who are more interested in the headlines than the facts, these kinds of things read well, they make good headlines, but in terms of promoting water quality they leave us somewhat behind the schedule.

The other caution -- you heard much on the dredged material today. There is an effort being made to remove all polluted material from the lake. What we call polluted is a bit difficult to determine. If there is organic material in it, I presume it is polluted. We have that in the bottom dredgings of most lakes unless it is in an area where it is washed clean.

The question is not whether or not the discharge of dredged material to the lake causes pollution, but whether or not it is polluted, per se. It is the same argument that Mr. Lyon raises on the oil wells. Are they pollution, per se, or could they cause pollution? I think there the defition is not so much: Are we dumping pollution into the lake, but: Are we causing it?

I sat in on the meeting of the Board of Consultants on the subject up in Buffalo, and I had hoped that the Colonel would report to you. He did indicate that they haven't found adverse effects so far, but he could have gone further.

The first preliminary data -- as one of the technical staff said, they are having difficulty to support, or interpret the data to support the conclusions that are drawn -- this is very real.

They are also finding that the material behind the diked area, the water quality behind the diked area is the same as the water quality outside the diked area. This raises the question as to whether or not material is by dry analysis polluted, whether it when put into water actually causes new pollution. This you should determine before you make your recommendations.

We are also into another area that indicates that the dredged material located behind diked areas can leach the nutrients, and the nutrient concentrations outside the diked area are higher than they are in, with the resultant bloom in the shallow water.

I agree with you, Mr. Chairman -- your comments this morning -- if you are going to blaze a path you should know which way it is going.

I don't envy you your job, but I think you have got the chance to do some really good leadership.

Thank you. (Applause)

CHAIRMAN STEIN: Why don't you wait. Maybe there are some questions or comments.

You know, Mr. Kinny, you came up and I guess if I live here long enough I am going to see everything. You praised Pennsylvania, you praised New York. If we both hang around these conferences long enough, one of these days I am going to hear you have a good word to say for a newspaper, and the next one is going to be the Federal officials. Then I will know the millenium has arrived.

MR. KINNY: I am guilty here of the thing that I have accused you of in the past, and I apologize, and that is by my commenting I would suggest that you have condemned all newspaper people. I said those people who would prefer a headline to the detail of what is going on. That is not all newspaper people; that is just a few.

CHAIRMAN STEIN: I never even noticed it was some newspaper people!

FROM THE FLOOR: Could I protect my headline?

CHAIRMAN STEIN: I am sorry.

Again, I would like to make one comment, because this is recurring. When Mr. Kinny said that the funds were cut back to $225 million, they weren't cut back at all. The last funds were $203 million. They asked for more money. This is the old game, again, and I hope we are going to be as sophisticated in dealing with these budget figures as you expect us to be in dealing with data. There are two arrangements in any one of our societies and legislatures, State or Federal: an authorization and an appropriation. They don't necessarily match.

If we had all of the money appropriated or every dime authorized by the Congress now, probably Jack Kinny would be leading his cohorts in fighting the kind of tremendous budget we have. The point is: until you have that money appropriated, you don't have it. I have heard this over and over again. If someone comes in and has a program, say, for $200 million, and then they ask for $500 million the next year and they get $300 million, you don't say they got $100 million more, you say they are cut $200 million.

Now, the point is this has not been cut back. Funds for this are going up all of the time. Maybe they are not going up as much as the cities and States want, but in actual funds there hasn't been a cutback.

Other comments or questions? Any other comments or questions?

Where is New York? Did the whole delegation leave? This is Mr. Haberer of New York. I know Mr. Metzler had to leave.

Let's go on to the summary. I think we have several points. One, I think it is only fair to say that the programs outlined by the five States here seem to be -- oh, we have another speaker? I am sorry, I didn't have your name. Come on up. I am sorry, and you told me before.

MRS. ANGEL: Mr. Estill and I signed pieces of paper. I hope you call on Mr. Estill, too.

The pollution problem is so great that the experts can't solve it, so that is why I am here. I am Mrs. James H. Angel, Chairman, Citizens for Land and Water Use of the Cleveland Metropolitan Area.

The Federal Government is calling for 92 percent removal of phosphates by 1972. During this time Citizens for Land and Water Use suggest that these things should be done:

1. Each municipality should provide posted directions to a legal dumping site; away from the lake and streams.

2. Strict enforcement of the litter laws.

3. Installation of sanitary sewage receptacles at all marinas and commercial ports.

4. Keep all dredge material out of the lake.

I would like to qualify this. I understand that there is to be a lot more study on the dredged material and the disposition of it. However, our reasons for saying that we would like to keep all dredged material out of the lake is because we have heard so much criticism that our Lake Erie is dying. It is true that it is the shallowest lake, and it seems reasonable to the lay person that if our lake is dying, and if it is shallow and if it is becoming a marsh, it seems reasonable to keep the dredged material out.

5. Reroute all raw sewage that is now

discharging to the natural storm drainage to the sewage treatment plant.

6. Accelerate the programs that will increase the efficiency of all STPs. Clean up sewage treatment plant effluent instead of or before discharging farther into the lake.

7. Good conservation practices by all citizens and all levels of government.

Small as these efforts may seem compared to the big programs being planned, the important thing is they need not be studied by a committee. Action can be taken now.

CHAIRMAN STEIN: Thank you, Mrs. Angel, for a very interesting statement. I would like to make one comment.

You say, "Small as these efforts may seem," yet No. 5 is, "Reroute all raw sewage that is now discharging to the natural storm drainage to the sewage treatment plant."

I think we have heard some testimony this morning from every city that isn't the small effluent.

MRS. ANGEL: But if you read my statement that was made to the State of Ohio, we have a little bit different opinion on that.

CHAIRMAN STEIN: I know, but you have to

recognize that rerouting the storm sewage generally is at least as expensive as providing treatment for the older cities. This is a very expensive program and we did hear that Cleveland -- and this is what I hope you citizens will do -- the engineers have come forward with a plan. The plan sounds very engaging at first blush. I suggest you look at this plan, if you haven't done so already, and form your own judgment.

MRS. ANGEL: All right.

CHAIRMAN STEIN: Thank you, Mrs. Angel.

Mr. Estill.

MR. ESTILL: Mr. Stein, conferees, ladies and gentlemen: This is a statement of the Ohio State Division of the Izaak Walton League of America.

I am Seba H. Estill, a member of the Clean Streams Committee of our State division and a member of our national committee on clean water.

Let's save Lake Erie now! Do many of you wonder what has happened to the "now" part of this most commendable slogan?

The Ohio Water Pollution Control Board's May 1968 Report and Recommendations on Water Quality for certain stretches of the Cuyahoga and the Grand River requests compliance with recommended water standards by January 1, 1975. This is getting much too close to ten years from the issuance of the Revised Conclusions and Recommendations of the conferees of the conference on pollution of Lake Erie and its tributaries on August 12, 1965.

I quote a paragraph from my statement for the Izaak Walton League at the November 30, 1966, hearing of the Ohio Water Pollution Control Board relative to the installation of suitable treatment works. "We realize that time will be required to develop and install such facilities. In the meantime, we propose that a use charge be imposed upon all polluters -- whether private, industrial, or municipal. That such charge be proportionate to the quantity and the type of the particular pollutants. We believe that such a charge would have a definitely dynamic influence in accelerating the installation of proper and effective facilities for the treatment of wastes." We are still of this same opinion.

In Minneapolis, on the twelfth of last month Under Secretary of the Interior David S. Black noted the importance of user charges.

If, in 1965, Ohio had instituted a use charge as above, we believe that it would have so accelerated the installation of proper control facilities as to render unnecessary the close to ten year time extension permitted for compliance with recommended water quality standards.

At the time of signing the Water Quality Act of

1965, President Johnson said, "No one has a right to use America's rivers and America's waterways, that belong to all the people, as a sewer." Also, guidelines established by the Department of the Interior state: "No standards of water quality will be approved which provide for the use of any stream or portion thereof for the sole, or principal purpose of transporting wastes."

It would appear that areas being assigned an industrial or aquatic life B water quality standard are being sentenced to that principal purpose of transporting wastes. Acting as sluggish sewers, in other words, and this function is in direct conflict withthe purpose and the intent of the Water Quality Act. The Izaak Walton League strongly protests this prostitution of public waters!

We have consistently advocated a water quality standard that is capable of supporting the propagation of a thriving and healthy population of warm water game fish that are indigenous to the area. This proposal is advanced in the belief that waters in which healthy game fish can survive and thrive should also be reasonably safe in human applications.

Ecologists, biologists, conservationists and just plain friends of clean water, seek future as well as present benefits, for our children and for coming generations of Americans. On the other hand, some municipalities, some politicians and some industries are much too prone to consider initial costs of abating pollution, but entirely ignore the simply staggering costs they are presently postponing and for which future generations must literally pay through the nose with smells that are not so sweet; with sludge and algae-filled waterways, which can no longer afford potable water for public supplies. They will pay with the barren banks of their eroded landscapes and the ecological sterility of their countrysides. They will pay with the vanished esthetic enjoyment of clean waters rushing between grassy banks that were once edged by fertile fens of fragile ferns. While these in turn were backed by gentle slopes of wild flowers and a profusion of fascinating flora and fauna that had once afforded pleasure to their visitors and instilled in them an active appreciation of the wonders and glories of God's handiwork.

Back in 1965, we were informed that if all pollution was stopped immediately that it might be possible to cleanse Lake Erie in fifty years. We believe that it is necessary to see that all streams flowing into Lake Erie are free from pollutants. Otherwise, with the premise that all streams having low water quality standards will carry some pollution into the lake, so that the aggregate load of corruption contributed by all tributaries combined, when consolidated into one overall total could be tremendous. How, then, are we ever going to clean up Lake Erie when authorities establish such low water quality standards, such as Ohio's industrial and aquatic life B classifications?

We don't think that Mr. Eagle or some of the other members of the Water Pollution Control Board probably like these standards any better than some of the rest of us do and we hope and we think that they do have in mind raising these standards later on, of course.

The flow of pollution into Lake Erie must be stopped. Stopped before any start to clean the lake can be effective!

The following is taken from a front page news report in the Cleveland Press just four days ago. I quote:

"On the basis of most recent data, the overall quality of Lake Erie is worse than it was in relation to 1964 data. I understand that Mr. Harlow will so report to this conference."

So, evidently Lake Erie is not holding her own against the filthy flood that continually fouls her waters.

Mr. Poston may be interested in this -- of the Metropolitan Sanitary District of Greater Chicago versus

The United States Steel Company, to restrain the latter from polluting Lake Michigan, Judge George N. Leighton, of the Circuit Court of Cook County, Illinois, agreed that there is no such thing as a little pollution. The judge continued. "I conclude as a matter of law that the oil slick in question was a pollution of waters as alleged in the complaint. Now, whether one characterizes it as a great amount or whichever way, it doesn't matter."

"The other question in this case presents whether on the evidence it shows that the defendant corporation discharged an oil slick either willingly or accidentally. I come to the conclusion as a matter of law, that it doesn't make any difference."

The judge then granted an injunction restraining the South Works of the United States Steel Company and the company has appealed.

In his Cleveland Press column of May 23, last, on Page E-12, Theodore Andrica relates an incident in the village of Misilmeri, Sicily, where a villager was murdered because of the terrible scarcity of water in the village. Mr. Andrica also noted that this lack of water is responsible for many slayings in Sicily.

The Creator triple-blessed our area with the gift of one-third of all of the sweet fresh water in the world flowing right by our door steps. Just what would those

Sicilian villagers think of us who live around the Great Lakes, who have turned that tremendous flow of fresh water into a giant sewer to dispose of our unwanted wastes? Just what will coming generations of Americans think of us?

Excerpts from remarks of the three gentlemen immediately following were gleaned from the conference in Detroit's Cobo Hall on November 6, 1965, on "United Action for Clean Water."

Dr. George B. Langford, Director of Great Lakes Institute, suggested that we bear in mind that clean, unpolluted, fresh water is the primary and the foremost asset of the area. None of the great resources and/or industries of the Great Lakes area are as important as our water resources.

Water is the resource of primary importance. None of the others are of value without water.

Conditions of our water are presently in a serious situation. We must spend, probably billions of dollars to correct these conditions.

The effects of many various chemical constituents in water, even in trace amounts, are not known; still we continue to drink the water. The drastic effects suffered by mothers who had taken thalidomide during pregnancy was cited and the suggestion put forth that no doubt many terrible results might follow the drinking of water containing so many harmful substances, even in trace amounts. He mentioned the example of Canadian and New York mink farm operators in discontinuing the use of perch from the areas as food for their mink, because it had been found that mink fed with such perch became sterile, and of no further use as breeders.

Secretary of the Interior Stewart L. Udall remarked that our once running waters were now but stinking, sluggish cesspools, and that rivers are very expensive sewers. He remarked that present polluters must make progress with the community, not apart from it.

Mr. Murray Stein (Now Assistant Commissioner of Enforcement for the Federal Water Pollution Control Administration; and our so efficient moderator today), noted that Lake Erie is being made into an enormous marsh and that when that state is consummated there is no return for Lake Erie. We must save Lake Erie now. He stated that industrial wastes must be treated to a degree equivalent to municipal sewage; that, "Every day of postponement of this problem makes for a much more difficult task;" that "If the Great Lakes go, industry will go with them. The United States will decline as a world power if the Great Lakes are not saved. The second battle of Lake Erie is a vastly greater problem than that of winning the first battle of Lake Erie."

Have we really been trying to win this second battle of Lake Erie or have we been merely temporizing with terminating the flow of corruption, choking away its very life? Let's really start now to save Lake Erie.

Thank you, gentlemen. (Applause)

CHAIRMAN STEIN: Thank you, Mr. Estill.

Do we have any comments or questions?

If not, does anyone else want to make a statement or have a comment? If not, let us try to get on and see if we can come to an agreement in various areas.

EXECUTIVE SESSION

I think we might state, each State looking at the other can indicate that we, I think, have a program moving forward in all five States, that the programs are substantially on schedule, and I don't use that word "substantially" as a euphemism for meaining that the schedules are not being met. The schedules are being met and the exceptions are being dealt with on a case-by-case basis.

Moves are being made to correct them, and there are very few cases that I noted here as recalcitrants, and where there are recalcitrants, the States are taking propriate legal action under their State law to bring them around. By and large, the major sources of pollution and the major dischargers are going ahead with corrective measures.

We have several problems that the conferees may want to deal with. One of these is the question of whether we should have a policy for the conferees, or a recommendation for the conferees on phosphates. We talked about substantial removal of phosphates. Michigan is asking for 80 percent removal. I suspect in the other States we may be getting, they are going for somewhat less and I think, as a matter of equity, we might consider whether we should have something fairly uniform for all of the States.

MR. LYON: I didn't hear what you said.

CHAIRMAN STEIN: As a matter of equity, I think we should try to at least approach the question to see if we can get something that is rather uniform for all the States in the basin. I understand -- Mr. Poston just showed me this -- the standards for Ohio were approved with that as an exception --

MR. POSTON: Phosphate removal.

CHAIRMAN STEIN: -- with that as an exception.

Now, I do think, gentlemen, that the Secretary of Interior is going to face up to this. I also, as I have said in the past, I always think it is better if we can go up and give him a unanimous recommendation from the States rather than get this done in another way. Now, I would like to hear how you feel we can best approach this problem.

Mr. Lyon.

MR. LYON: Well, I will repeat my earlier recommendation. It is primarily based on the fact that Michigan is taking the leadership in this and has adopted its standard of 80 **percent** phosphate removal from sewage treatment plants. Michigan is the major source of phosphates to the lake. It would seem appropriate for the other conferees to adopt that standard.

CHAIRMAN STEIN: Do you care to comment now, Mr. Poole?

MR. POOLE: Well, I don't see how we could do otherwise than 80 **percent** because we adopted 80 per cent for the Lake Michigan cities, and I would have a little trouble explaining to them that something less than that was all right for the Lake Erie cities.

CHAIRMAN STEIN: Mr. Oeming.

MR. OEMING: No comments.

CHAIRMAN STEIN: How about Mr. Haberer?

MR. HABERER: I think Mr. Metzler explained pretty well his feeling on it and I don't think he is ready to adopt an 80 **percent** or an 85 **percent** removal at this time.

CHAIRMAN STEIN: Well, I don't think anyone suggested 85 as a minimum. I think, and I hope I am stating scientific testimony -- if it didn't appear in this record, correct me -- that as far as I can see, our scientists say that 80 percent is the minimum and really that they expect that 90 percent is achievable.

How about you, Mr. Eagle?

MR. EAGLE: Well, Mr. Chairman, I would like a point of order here now. If we are going to depart from the conclusions and recommendations of the 1965 conference, then I think that there are an awful lot of people that want to be heard on this matter, and as far as I am concerned, I think we are going to be back to a public hearing.

CHAIRMAN STEIN: By the way, I don't know if this is a departure. What we have talked about at the 1965 conference was a substantial removal of the phosphates.

MR. OEMING: Maximizing.

CHAIRMAN STEIN: Maximizing.

Now, the point is: When we started back at that time, we knew we were feeling our way in the phosphate program. The question here as I look at the proposal is just to refine what we have done, as we have always tried to do, to put a number on it. As I recall this original conference, Mr. Oeming for one, and rightly, was pushing us for numbers and what we precisely meant on all of the conclusions.

MR. EAGLE: One of the conclusions was that we appoint a technical committee which was done, and they spent several months, as you know, in considering this problem, and came up with a report which was accepted by these conferees, and as far as Ohio is concerned, has been made a part of the Lake Erie standards.

I think that certainly this technical committee should be given consideration here, and if it is the wish of the conferees -- and I would certainly go along with that -- that this matter could be referred back to the technical committee for consideration and for further recommendations.

CHAIRMAN STEIN: Well, now, you may want the technical committee -- again, we have several of our scientific people, and in other States the scientific people have made some significant advances, it seems to me, even from the time we had this technical committee.

Now, we can accept the committee of the conferees, or we can have, if you wish within a short time, if you want to get the conferees together -- and I am just putting this out as a feeler -- a meeting on the phosphate question alone, where we will get the scientific people to outline what they have to say about phosphates and have anyone else come in, and then we can get this information lined up.

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Now, I think this is a question of the work of the committee -- the scientific work -- being fairly straight forward and laid out. Where we set up this technical committee, they were looking for analyses. I think within a relatively short time we can make a -- and I think all of the people who have views on this phosphate question -- can make their views known to the conferees.

MR. OEMING: Mr. Chairman, I would like to clear up something here about this committee; if my recollection is correct, the assignment to that committee was to determine the magnitude of the various sources. This is one thing.

Number two, what kind of water quality in terms of phosphates you wanted in the lake. This committee was not the kind of committee who could then relate that to processes for the removal of phosphates.

Now, let's take another step. This grew out of the conference at Cleveland and Buffalo -- the initial conference -- and if you will recall, nobody at that time was in the position to say what degree of removal was necessary, but we did establish, after a great deal of discussion and probing -- and I know that I probed deeply -- as to what quality these experts who testified wanted in the lake that would remove or reduce the nutrient problem to manageable levels. This is what we came out with.

Now, somebody along the line has to decide what loadings can come out of the various areas that are contributing these phosphates. Now, 80 **percent** is not a magic number. It might have to be 90. It might have to be 85. It so happened that in the analysis of the Detroit River contribution, it came out to 80 **percent.** At that time we didn't know in Michigan any way to get there, but somebody has to lay down a requirement for people to meet. Otherwise, we drift along, and so this is the reason that the 80 **percent** removal was established, because that was decided from the conference in terms of concentration in the river that would be manageable, and it came out at 80 **percent.**

Now, I am a little puzzled as to what this committee could do beyond what has already been in the record, to a great extent, of these conferences. This is where I am in a little fog here.

CHAIRMAN STEIN: I am not sure that they could do very much of anything. I think the question that we have -- and as I understood Mr. Metzler, he was talking in terms of the cost of this and the reliability and so forth and so on. I think the issue we have to face is if we have a notion of what the water quality requirements are in terms of the nutrients we can put in, I think there also has to be a judgment made as to the devices that are available and what you have to do to get this.

Now, I am not sure that the committee that we have set up are the people to deal with that problem. I am not sure -- as a matter of fact, we have done this in the past with the Lake Michigan situation -- we have called on the experts who can supply the answers to these questions.

MR. OEMING: Well, Mr. Stein, let's clear up one question at a time.

Are we questioning, at this time, the limitations or the criteria that were proposed and accepted finally by this conference for the water itself?

CHAIRMAN STEIN: I don't think so.

MR. OEMING: Well, I wonder --

CHAIRMAN STEIN: No, I think this is based on the scientific fact. By the way, I don't see any reason for that. The facts haven't changed. A certain phosphate concentration, I think, was agreed on by the scientists, triggering this operation. The notion is to keep it lower than this concentration.

Now, I don't think the scientists have changed their judgment there. In other words, I wouldn't hesitate to entertain the notion to change it if there were new scientific evidence, but there isn't. The only thing that has come up new since that time is precise information on effective treatment and costs which can be made available to the conferees.

MR. OEMING: Well, but, Mr. Chairman, hasn't there been two conferences within the last few weeks to which everybody in the country has been invited --

CHAIRMAN STEIN: Yes.

MR. OEMING: -- to explore all of the technical information that is available?

CHAIRMAN STEIN: That is correct.

MR. LYON: If I may say something -- I completely share this view that there has already been a conference. There also has been a meeting, I understand, of the FWPCA people on this question. There were a number of papers given that showed that phosphate removal was possible to that level.

The basic question is: Do we move now? After all the test quality levels that were established by the technical committee, we don't know whether we are going to attain those or not with that 80 percent removal. We certainly are going to come closer to it than we are now.

CHAIRMAN STEIN: That is right.

MR. LYON: And it seems to me we have all agreed for a long time that this is a major problem in this lake and it seems to me the time is now.

CHAIRMAN STEIN: Well, this is, again, up to the conferees. Since we have three conferees -- if I read this correctly -- who would say that to maximize the phosphate removal would mean a minimum of 80 percent, and I understand that two conferees are not prepared to go along with that. Is that correct?

MR. EAGLE: Yes, it is correct as far as I am concerned. I am not prepared to go along with that at this time.

CHAIRMAN STEIN: Well, what would you suggest as a course of action to try to get us together, if anything?

MR. EAGLE: Well, I suggest that we must explore this thing further at this time, and that we set up a special conference and have the people that are going to be affected and who are going to have to pay for this -- give them an opportunity to be heard.

MR. HABERER: We don't want to be negative in New York State on this subject. We just feel that we have such a big problem ahead of us, we want to get out the sewage; we want to get the stormwater and the chlorination taken care of. Phosphorus is an important part, but after all it is kind of down on the bottom of the totem pole as far as the other work that we have to accomplish here and many of these communities have primary plants that have just been built. We are now insisting they go to secondary, and now to hit them again to go to another degree of treatment, which although percentage-wise as far as the initial cost is not as large, nonetheless the operation is large.

We also remember in New York State they pay one-third of the cost of the operation of the sewage treatment plants, which I don't think any of the other folks do, so this is kind of a hunk of money that we have got to look forward to.

CHAIRMAN STEIN: We are asking, as I understand it -- this was a decision made to maximize the phosphate removal here.

I think we are dealing with a very important resource here in two of the major States who presumably are not in complete agreement with three other major States, i.e., New York and Ohio. I would suggest, if the conferees agree, that we set up this: have the technical experts indicate what the situation is -- and I don't mean one of these real technical meetings at which they are going to explain all of the details of the process -- and give Ohio and New York and any other States and any other industry or municipality that wants to come in and talk about this; follow Mr. Eagle's suggestion on this and see if we can come to a resolution of the issue because I think this is a vital one.

MR. EAGLE: I would like to point out, I presume we are talking about the entire Lake Erie Basin?

CHAIRMAN STEIN: Yes.

MR. EAGLE: Then, we are talking about some 150 treatment plants and we are talking about hundreds of millions of dollars a year additional expense. And going into something like this, I think we should have certainly as a very minimum a full-fledged hearing, an opportunity for these people to be heard.

CHAIRMAN STEIN: Mr. Eagle, I don't dispute that at all, and I think considering what is at stake and the amount of money, the interest, and all that, let us -- if the conferees are agreed to that -- we will try to get the staff together with you, get a mutual agreeable date and I hope we can agree on a short presentation by a few people who can present the phosphate problem.

For example, the people that I would guess from the Federal Government -- and I don't want to put the finger on any particular one now -- but someone like Fritz Bartsch, who could talk about the biological effects -- that is Dr. Alfred Bartsch -- and Dr. Leon Weinberger, who probably could talk about the technical aspects and the application, and I know that both of these fellows could make about fifteen-minute presentations each on this.

By the way, I am not speaking for them, because I haven't spoken to them, but someone like that, and the States might want to get some people out, and then we can give all of the industries and municipalities and people a full-fledged opportunity to be heard.

MR.EAGLE: I would suggest that your report be put out in advance of the meeting so that these people who are going to be affected would have an opportunity to study it and come to the meeting prepared to make their comments, like we do on our regular conferences.

CHAIRMAN STEIN: That is right. I suggest for those people who want to do a little advance work on that, I think Dr. Bartsch and Dr. Leon Weinberger's views are fairly well known, and they are available from the group here. You people can almost make those statements and their views on this available immediately, but this will be done. I suggest that before the program goes too far ahead and we have to backtrack, while we are getting the plans in, before we have really begun to let the contracts, that we come to a determination on this one way or the other because this would be the way to do that.

Is this agreeable to all of the conferees?

MR. OEMING: Mr. Chairman, I am not sure I know what the agreement is, yet. What do you expect the role of

Indiana and Pennsylvania and Michigan to be in this agreement?

CHAIRMAN STEIN: I would expect that you would participate in the meeting, listen to the arguments on all sides, if there are arguments, and the views expressed by all parties, and approach this with the same kind of open mind that we would expect New York or Ohio or us to approach it, and see if we can come up with a mutually-agreed-upon position for Lake Erie.

MR. OEMING: I am sorry, but I don't have an open mind anymore. My mind is closed, and we have decided what we need to do.

CHAIRMAN STEIN: Well, again, I hope you would do this. The point is, Mr. Oeming, if you had more rigid requirements than we decide on for the rest of Lake Erie, I am sure no one will mind.

MR. OEMING: I don't know as I want to be put in that position of beating the other States over the head, Mr. Chairman. I want to be in the position that I am in and Michigan is in, that it recognized its responsibility.

Now, if you have any criticism of it, that is fine. We should get at that, but I don't know what else I can offer.

CHAIRMAN STEIN: It is not a question of beating anyone over the head. We are trying to get a joint position developed by the States, by all you people, that we all can live with.

Now, Mr. Oeming, we have a situation here -- you can see what we are headed for.

MR. OEMING: I am in sympathy with these people.

CHAIRMAN STEIN: I think this is the best way to settle this. We have standards submitted by Ohio, which have been accepted by the Secretary of the Interior, except for the phosphates. I would think that the best way we can do this and help the Secretary and help the States is try to get the five States together with a unified position, instead of letting it go to any kind of a judgment which is going to have to be made one way or the other. I am suggesting that this tradionally, while it is a hard row to hoe, in the long run is the easiest way to do business. I don't want to have a confrontation between the Federal Government and any State on a fundamental issue like this and I don't want to have the States divided.

So far we have been able to come up with unanimous suggestions. I am suggesting we make the college try here and take Mr. Eagle's recommendation and go ahead and see if we can achieve this.

MR. OEMING: Let me ask this question. I think it is not appropriate, but I am going to take that chance.

Does Mr. Eagle or Mr. Haberer feel that Michigan should be a part of this conference? Is there any purpose served by this in your opinion?

MR. EAGLE: As far as I am concerned, it is all right either way, Loring, participation or not. You have made your decision and if you don't wish to participate, I think this is going to be all right.

MR. OEMING: I wondered if there was a purpose.

CHAIRMAN STEIN: There may be some modifications, Loring.

You are not sure they are going to come out with the view you have accepted. Wouldn't you want to try that?

MR. OEMING: Well, I don't want to try it and change the ground rules for the people that we have got working now.

CHAIRMAN STEIN: No, and I think if you -- this is the kind of position that would make a contribution to the meeting.

MR. LYON: Mr. Chairman.

CHAIRMAN STEIN: Yes.

MR. LYON: May I suggest that we might have another alternative? I am a little concerned with the desirability for another hearing, because in Pennsylvania when we order our municipalities to do this, they still will have an opportunity for hearing, and I suspect this may be true in the other States. In other words, the issues can still be heard from the technical standpoint. We just had a meeting in Chicago with the FWPCA and many others who presented ample information about phosphate removal. Might it not be desirable for us to consider having at some time in the very near future an executive session of the conferees where we possibly could iron this out?

CHAIRMAN STEIN: Well, this is a possibility, but I -- listening to Mr. Eagle's proposal, and I can sympathize with his point of view -- think what we can do in the executive session is give you the technical views and the scientific views on how this is to be done.

What Mr. Eagle was pointing out is that, I think, he would like to get before establishing this an airing of the views from the policy standpoint of the people who are going to have to bear the cost and pay for this. Frankly I think that there may be something to doing that and getting those views.

MR. OEMING: I question, though, Mr. Chairman, if that is not a function of the individual State to do. This is what each of the States were supposed to do after the conclusions of the Secretary at the original conference, and each of the States went back and decided what they were going to do. This is how Michigan arrived at its 80 percent. We didn't come back and ask for a conference of all of the other States to persuade our citizens that they had to do this.

CHAIRMAN STEIN: I understand that, sir, and if we had been able to achieve that in other places -- but it is obvious here that we are fairly evenly split. We are trying to look for a device to get all of the five States operating in concert here. I don't think that we are going to do the cause of pollution control much good if we don't really make an effort to come up with a unanimous recommendation from the five States. After all, look at all of the good work you have done.

Now, we have been able to do that in the past. Very frankly I would be dismayed to just go in with this kind of split and let nature run its course without having the States look at this again. Under the law, the Secretary's duty is clear. He is going to have to make a judgment. I would like to see if we could come up with something, as we have always done before, where I could say all of the States are pretty much in agreement with this; isn't this a good thing to adopt?

MR. OEMING: I will defer to your judgment so long as this does not run the risk of changing the

Michigan program, lowering it from 80 percent to 70 or 60.

CHAIRMAN STEIN: We won't drop your program. I don't think we ever have. In other words, if Walter Lyon came in here and said that you had the minimum of 80 and he said he wanted 96, no one would suggest that we would drop it.

I don't think there is any danger that the program can be dropped. I would suspect, given the attitude of the two States, I don't know that your program would be dropped, but I am sure that they are not likely to adopt one that is higher than yours, either, so I think you are relatively safe.

MR. HABERER: What did we mean when we said maximize, in the first place?

CHAIRMAN STEIN: Now, the point is, you have to put that back to the period where we were working. The point is, what we asked was: What was a reasonable degree of phosphates and what was the amount of phosphates you could take out? At that stage, we didn't have the answers to these from the technical people. However, they came up with a notion for every pound of phosphates you took out you would have less of this growth, and decelerate the eutrophication process; so we did the best we could in the State of New York, knowing we would have to go with this again. We put in this "maximize" so that hopefully the engineers would come up with plans to get the phosphates removed. If you can put yourself back to those days, the notion then was a little different than we have now. At least the main thrust of the thinking in phosphate removal was by a Detroit design and operation of the sewage treatment process and taking some of the supernatant off of the line at a particular point, you are going to achieve remarkable results.

They tried that. It worked in some places, but they couldn't duplicate that at will in other plants, and it just was not the kind of thing that you could recommend to be sure.

So, now, the main thrust has shifted to chemical precipitation or some kind of precipitant action or getting floc. In other words, we are really in a different ballgame now than we were when we started this thing, and we were just groping our way and hoping that someone would come up with a solution.

As a matter of fact, the program worked out sort of as we expected, because by spotlighting the problem, placing a bonus on someone coming up with maximized developments, they have produced it.

Now, our people think that 90 per cent removals are going to be suitable very shortly. You know they are always a little ahead.

Now, I think Mr. Eagle has a point, and I am saying this for the phosphate program as a whole: The decision has been made. It is the decision that has been made largely on the scientific evidence. If you want to have it on the basis of the social impact and the people who are going to pay for it, I think it might be good to look into it and get the other views.

What is the result of the caucus? Are we agreed?

MR. OEMING: The caucus results are that two of the States -- maybe three -- are concerned about the adverse effects on what we have already done in Lake Michigan. We open this whole question again, and I am concerned whether we mean it or not that that might be the result.

MR. EAGLE: Well, Mr. Chairman, I have an alternative. If the other conferees don't want to have this, Ohio can have its own public hearing and following that, then, we will be prepared to make our decision. I am not prepared today to make any decision.

CHAIRMAN STEIN: Mr. Poole.

MR. POOLE: I appreciate everybody's concern, and I believe a good deal of this is over maybe not so much the percentage you remove, but the cost of removal, and this is a genuine concern to us in Indiana. I would hope that we don't have to embark on a program where next year you have got to let contracts for every plant that is producing phosphates in the basin, because there is reason to hope that maybe within a couple of years we will have cheaper processes. But I can't see that that has a great deal to do with a decision on the percentage of phosphates that ought to be removed from Lake Erie.

Now, I have been involved in both Lake Erie and Lake Michigan, and I am under the impression that the phosphate levels at the present time in Lake Erie are greater than they are in Lake Michigan, and if that is the case, and if we concluded that you need at least 80 **percent** phosphate removal in Lake Michigan, I can't for the life of me see how that, regardless of how many more conferences we have and how many more speeches we listen to, that we can conclude that Lake Erie needs less than 80 **percent**..

I would be prepared to get into this argument -- if you start talking about timetables and want to collapse this all into a very short period of time --

MR. EAGLE: Isn't that what we are talking about, Mr. Poole, putting schedules on these for construction and operation?

MR. POOLE: Well, we haven't started that yet.

MR. EAGLE: This is what I thought was involved. If we are just going to say it should get 80 percent, sure, we can prescribe to that. We are talking about schedules.

CHAIRMAN STEIN: I think you may be convinced without anymore talks or speeches, but I don't think we have the unanimity. The point is: If we are going to be able to get you people together, we have to have some dialogues, and I don't know where it is, and I am not sure that just an Ohio meeting can do this. We have to have some kind of dialogue among the conferees to try to achieve a program that you all can agree to for Lake Erie. At least try this, and I think this is the mechanism we are trying to set up, and I think once you go your separate ways, we are just not going to do it. There is some way we are going to have to get together, and I would like to satisfy all of the conferees on this.

MR. POOLE: I am willing for another get-together if you will consult me and let me look at my calendar, but I don't like these notices that you be in Cleveland on X date. It just happens I can't be here on any day in June.

CHAIRMAN STEIN: You don't really get notices like that from us, do you?

MR. HABERER: Could I speak for just a half second here? I thought you were talking about immediately putting in some kind of a schedule, and this is my belief, now, as far as doing something about it. We are doing something about it in New York State. Every set of plans that comes in, the engineer has to show us what he intends to do on phosphate removal, but we don't say when, and he also has to indicate on the plans space-wise and hydraulic-wise how he can get rid of the phosphates. They are coming along also with a cost estimate, so we are instilling this in the engineers, and they, in turn, are taking it back to their people and the communities realize that this day is coming, but the day is just not here today, that is all I am saying.

MR. EAGLE: I certainly concur in that, and, Mr. Chairman, if we aren't talking about schedules we might as well forget the whole thing.

CHAIRMAN STEIN: No, we have got two points, and I think Mr. Poole pointed that out, too.

One is the amount. The question is: How much phosphate removal? I think the group knows that you are not going to approve it unless you get 80 percent removal, and they know what they have to do and the magnitude of the problem. That is the first step of what you are going to require.

Now, in Lake Michigan it came up, and I agree with you, we did come up with a schedule and, what was it, 1972 for phosphate removal? I think both of these are tied up. You gentlemen were right. I sure did mean a time schedule and an amount of removal.

Let me give you my view: I sense that we have to think this out and talk this out a little more among us. I would recommend that we make arrangements to get together on a meeting of phosphates as soon as it is reasonable.

MR. POSTON: Executive session, or otherwise?

CHAIRMAN STEIN: No, you can have both.

Now, there is no problem in that kind of thing. If Mr. Eagle thinks it would be helpful to have the people come in and have the industry come in, you can have that. You can have the scientific people and you can have the executive session. Just give us two days next time, fellows, please, and we can have all that if that is what you want. There may be a reason for an executive session, but I don't see it now.

Are there any other comments on this?

MR. LYON: Mr. Chairman, I just wanted to point out that in our submission to the Secretary of the Interior, we said, in connection with our abatement implementation plans, that we would follow, as far as phosphates were concerned, whatever the conferees would agree on, so it will have to be understood that if there is a delay on a decision in this that our implementation will have to be delayed.

CHAIRMAN STEIN: Again, let me say: I think the phosphate decisions you are going to get and the most equitable decision is if we can get the States together. The other alternative is a confrontation, and that is what I would like to avoid.

MR. LYON: I certainly share your feeling.

CHAIRMAN STEIN: And I think we are so close together that this is not the issue.

Well, let's see if we can set up that meeting.

Now, are there any items we want to bring up for the summary of this conference?

MR. OEMING: Mr. Chairman, you discussed quite at length the boating requirements.

CHAIRMAN STEIN: I wanted to bring that up. Do you think it would be worthwhile to do what we did -- I am sure I think a committee might be in order -- to do what we did in Lake Michigan, and then have the States get together to see if they can come up with a unified recommendation on boating requirements?

Now, this is a very helpful operation, from just administering and living in the State, because a man will take a boat in one State, and problems we have on Lake Michigan -- drive across the waters -- not Michigan, we had this in two other States where we have the problem, right next to each other -- one State has one requirement and another has another, and every man who drives across the State line finds himself subject to arrest and is often arrested. This doesn't make for very good relations.

Now, would it be agreeable if the people from the States -- and I don't know if you want a Federal man -- you can have him there as a consultant, but this really is a State matter -- the people from the States establish a committee and report back to the conferees? It took about sixty days, but they could report back to the conferees in sixty days whether you want an agreement on the boating regulations.

MR. POOLE: Mr. Chairman, I would like to clarify. We have talked off and on all day about the Lake Michigan agreement on boats, and my recommendation of the treatment was that the four Lake Michigan States agreed to get together to develop a uniform program which involved legislation that was necessary for pleasure boats, and then the State conferees recommended that the Federal Government pick up the lead and/or the ball and develop regulations for commercial vessels.

MR. OEMING: Right.

MR. POOLE: The Federal conferees didn't vote on that part of the recommendation because they can't get involved in recommendations on Federal legislation, but, Loring, isn't this correct?

MR. OEMING: You are correct, absolutely.

CHAIRMAN STEIN: Well, if you want to do that, that would be fine.

MR. POOLE: Well, I certainly wanted to reiterate what I said in Chicago, and that is that this business of commercial vessels has got to be looked at as well as the pleasure boats that go out for a few hours or overnight or on the weekends.

CHAIRMAN STEIN: Right. Well, I agree, and if that is the consensus of the conferees, we will do that and hopefully we will have a report from the States in two months.

MR. LYON: Mr. Chairman.

CHAIRMAN STEIN: Yes.

MR. LYON: What you have said about the States is equally true about Ontario, and I know they have done a lot in this field, too. Isn't there some way that we can bring Ontario into such a meeting?

CHAIRMAN STEIN: You can bring them in -- off the record.

(Discussion off the record.)

CHAIRMAN STEIN: Let's go back on the record.

MR. EAGLE: Are you going to notify us and ask us to nominate people to this committee, then?

CHAIRMAN STEIN: Yes, we will provide the secretary and the clerical work and the advisor, but I would suggest that when you get to the committee, you designate one of the State people as chairman.

MR. EAGLE: Well, yes, we have got a different group of people on this kind of a committee.

CHAIRMAN STEIN: That is right.

MR. EAGLE: The Division of Watercraft in our Department of Natural Resources will be very much involved in this.

CHAIRMAN STEIN: Right.

MR. EAGLE: It is going to have to be pretty much their decision.

CHAIRMAN STEIN: Yes, and the question, again, is if we can get a decision. If we can get a decision on this, I think --

MR. EAGLE: But you will notify us about the committee and about the nomination?

CHAIRMAN STEIN: Yes, because it will make life a lot easier for people who own boats on the lake if we come up with uniform regulations. As I say, if we are looking for a national policy, the more States we can get together and the more regional operations we can get, the farther we are up to beginning to meet this problem throughout the country, but we may be going in through the back door, but let's do what we can.

All right, are there any other comments?

MR. POSTON: Mr. Chairman, I would raise the question, then, on dredged material. We are comparing this with Lake Michigan, and inthe Lake Michigan conference it was the recommendation that we ask the Corps of Engineers at the end of six months to come back with proposals on elimination of dredged materials being dumped into the lake.

CHAIRMAN STEIN: Do you want to do that? You had something on agriculture, too. I don't know who raised that question on agriculture on the run-off.

MR. EAGLE: Mr. Metzler.

CHAIRMAN STEIN: There were two things we have worked on. We have asked the Department of Agriculture to come back with their report for us in six months on a program to protect the lakes from agricultural run-off and associated materials for consideration of the conferees to see what we can do to meet that problem. I would hope that if we adopt that, that the Federal Department of Agriculture would get together with the State counterparts which I am sure that they would. The other thing is we have asked the Corps of Engineers to come up before the conferees, the same as any of the

States or anyone, with a specific program of what they are going to do on your lakes vis-a-vis dredging, and for consideration of the conferees.

Do you want to adopt those as recommendations?

If there is no objection, I think that both might be a good idea and very helpful and might save the lake or improve the lake.

Any other suggestions on what we may take up? Are there any more suggestions?

If not, I think at least we have demonstrated that we have a program going to abate pollution in Lake Erie. I think the other thing is that we grappled with some of the more esoteric problems in handling the lake.

I think we are pretty much agreed on time schedules and treatment for industrial and municipal waste treatment, even for complicated processes. This is well underway. The recognition is that there are various other aspects of the lake pollution problem that we would have to consider.

I think to expedite the recalling of meetings, I would also suggest one other thing, that the meeting be called at the call of the chairman, because at least when it goes through me, I check with the States first. I don't put a letter out without getting in touch with you on the dates first.

I think there is evidence of substantial progress here. I can see, I think, the light at the end of the tunnel, that we are going ahead. We will have to, it seems to me, all of us, stay on top of all these individual projects and see if they can come through.

With the announcement of the proposed bond issue in Cleveland, I think we have a major development, and this is one of these milestones we are going to have to pass if we are going to clean up the lakes. Speaking for at least the Federal Government, we and the staff with all our resources intend to help Mayor Stokes in any way possible, at his request, to help him do any of the work he wants with the bond issue. Maybe the best help we can give is to get him to stay home, but I think we may be able -- if that is the best we can do -- we would be glad to do that, too -- but we may be able to help. We have been experienced in bond issues in other towns and have been called on, for example, in St. Louis when they put their bond issue across.

By the way, that is a very good campaign to look at. That probably was one of the most successful sewage bond issues put forward. I think we are going to have to watch the program very, very closely, because we are playing for big stakes. There is a lot of money, and while we have an agreement and a program moving forward, there are several contingencies that are lurking in the program, and those of you who have listened to Mr. Poole's repeated question know what the major one is, and it is a five-letter word spelled M-O-N-E-Y.

I think if we keep our cool and proceed as we have done, we are going to abate pollution in the lake and move forward.

I would like to thank all of you for coming here, participating with us, and those who have stayed with us to the end, and this conference or meeting stands adjourned.

Thank you.

(Whereupon, the conference adjourned at 6:30 p.m.)

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